
**OPERATION & MAINTENANCE MANUAL
GROUNDWATER TREATMENT PLANT**

US EPA RECORDS CENTER REGION 5



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Volume 1 of 11

OPERATION & MAINTENANCE MANUAL / CONTINGENCY PLAN

**AMERICAN CHEMICAL SERVICE NPL SITE
GRIFFITH, INDIANA**

MWH File No.: 2090601

Prepared For:

**American Chemical Service NPL Site RD/RA Executive Committee
Griffith, Indiana**

Prepared By:

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27755 Diehl Road, Suite 300
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July 2002



MWH

MONTGOMERY WATSON HARZA

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<i>VOLUME 1</i>	<i>Operations and Maintenance Plan / Contingency Plan</i>
VOLUME 2	Performance Standard Verification Plans A. PGCS PSVP and QAPP B. BWES PSVP and QAPP
VOLUME 3	Construction Completion Report/Completion of Remedial Action Report
VOLUME 4	As-builts for the PGCS and BWES
VOLUME 4A	As-builts for the GWTP Upgrades
VOLUME 5	Equipment Manufacturer's Manual – Instrumentation and Control Equipment
VOLUME 6	Equipment Manufacturer's Manuals
VOLUME 7	Equipment Manufacturer's Manuals
VOLUME 8	Equipment Manufacturer's Manual – UV Oxidation Unit
VOLUME 9	Equipment Manufacturer's Manuals - GWTP Upgrade Equipment
VOLUME 10	Equipment Manufacturer's Manuals – Activated Sludge Plant and Catalytic Oxidizer/Scrubber
VOLUME 11	PLC Programming Logic

VOLUME 1 OF 11

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APPENDIX

Appendix A	Literature on PID Control Loops
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ACRONYMS AND COMMON TERMS

ACS	American Chemical Services
“Auto”	Automatic operating mode setting for equipment selected an HOA switch
BOD	Biological Oxygen Demand
BWES	Barrier Wall Extraction System
CAH	High pH alarm
CAL	Low pH Alarm
CAT-OX	Catalytic oxidizer and scrubber unit (ME-106)
CE	pH sensor/probe
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CIC	pH indicator and transmitter
CO ₂	Carbon Dioxide
COC	Chain-of-Custody for sample transportation and analysis
COD	Chemical Oxygen Demand
CPI	Corrugated Plate Interceptor oil/water separator (ME-1)
DAH	High turbidity alarm
DIC	Turbidity indicator and transmitter
DM	Turbidity meter
DNAPL	Dense non-aqueous phase liquid (tar)
DO	Dissolved oxygen
DOT	Department of Transportation
ERCP	Emergency Response and Contingency Plan
EW	Designator for BWES extraction well
EP	Designator for the PGCS electrical well pumps
FAL	Low air flow alarm (from blowers or air compressors)
F/M	Food to microorganism ratio for activated sludge plant
FE	Flow measuring element (part of a flowmeter)
FIT	Water flow rate indicator and transmitter
FM	Water flow meter
FS	Low air flow indicator switch
GAC	Granular activated carbon unit (ME-33 and ME-34)
gpd	gallons per day
gpm	gallons per minute
GWTP	Groundwater treatment plant
H ₂ SO ₄	Sulfuric Acid
“Hand”	Manual operating mode setting for equipment selected an HOA switch
HASP	Health and Safety Plan
HDPE	High density polyethylene
HOA	Hand/Off/Auto switch for operating modes of equipment
hp	Horse power

ACRONYMS AND COMMON TERMS

(Continued)

HS	Hand switch
I&C	Instrumentation & control
IDEM	Indiana Department of Environmental Management
ISVE	In-situ soil vapor extraction
kg	kilogram
K-P Area	Kapica-Pazmey Area (located at the south end of the Off-Site Area)
KS	Alternator switch
kW	Kilowatt
LAH	High water level alarm
LAL	Low water level alarm
LC	Level Controller
LCP	Local control panel
LE	Continuous water level meter
LH	High Level
LIT	Water level indicator and transmitter
LL	Low Level
LNAPL	Light non-aqueous phase liquid
LS	Water level switch
LSH	High water level switch
LSHH	High high water level switch (usually for alarm indication)
LSL	Low water level switch
LT	Level Transmitter
µg/L	microgram per liter
mA	milliamp (electrical current)
MCC	Motor control center
MDL	Method detection limit for analytical analysis
ME	Mechanical equipment designation
mg/L	milligram per liter
ml	milliliter
MLSS	mixed liquor suspended solids (total suspended solids in activated sludge)
MLVSS	mixed liquor volatile suspended solids (biomass)
MMI	Man-machine interface (the GWTP control computer)
MSDS	Material Safety and Data Sheet
NAH	High Torque Alarm
NaOH	Sodium hydroxide (caustic soda)
NAPL	Non-aqueous phase liquid
NH ₃	Nitric Acid (used as supplemental nutrient for activated sludge)
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
O&M	Operation & Maintenance
OFCA	Off-Site Containment Area (the area of high contamination in the Off-Site Area)

ACRONYMS AND COMMON TERMS

(Continued)

"Off"	Off setting for equipment selected an HOA switch
Off-Site Area	The area within the barrier wall south of the railroad tracks
ONCA	On-Site Containment Area (the area of high contamination in the On-Site Area)
On-Site Area	The area within the barrier wall north of the railroad tracks
OSHA	Occupational Safety and Health Act
OUR	Oxygen Uptake Rate
P	Pump designation
P ₄ O	Phosphoric acid (used as supplemental nutrient for activated sludge)
PC	Personal computer
PCB	Polychlorobiphenyl
PGCS	Perimeter Groundwater Containment System
PID	Proportional, Integral, Derivative
PLC	Programmable Logic Center
PM	Project Manager
PP	Designator for the BWES well pumps
PPE	Personal Protective equipment
PS	Air pressure switch
psi	pounds per square inch
PSVP	Performance Standard Verification Plan
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAS	Return activated sludge
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
rpm	Revolutions per minute
RUN	Equipment operation indicator light
S.U.	Standard unit of pH measurement
SBPA	Still Bottoms Pond Area (located within the ONCA)
SCFM	Standard cubic feet per minute of air/gas flow
SF	Square Feet
Site	All of the individual ACS areas are collectively referred to as the Site
SSO	Site Safety Officer
Stage 1	Dewatering period for the Off-Site Area
Stage 2	Dewatering period for the On-Site Area
Stage 3	Long-term maintenance dewatering period
SV	Solenoid Valve
SVOC	Semi-volatile organic compound
T	Tank designation
TOC	Total Organic Carbon
TSS	Total suspended solids

ACRONYMS AND COMMON TERMS

(Continued)

U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Society
UV-OX	Ultraviolet oxidation unit (ME-2)
VDC	Voltage, direct current
VFD	Variable frequency drive motor for pumps
VOC	Volatile organic compound
VSS	Volatile suspended solids
WAS	Waste activated sludge

1.0 INTRODUCTION

1.1 MANUAL USE AND ORGANIZATION

This document is the Operations and Maintenance (O&M) Manual and the Contingency Plan for the Perimeter Groundwater Containment System (PGCS), the Barrier Wall and Associated Extraction System (BWES), and the Groundwater Treatment Plant (GWTP) which were installed as expedited remedial actions at the American Chemical Service (ACS) Site in Griffith, Indiana. Construction of the original GWTP including the PGCS and BWES extraction systems was completed in 1997, and significant upgrades were completed in December 2000 to meet the expected groundwater extraction quantity and treatment required to implement the Final Remedy. This document is Volume 1 of the overall Operations and Maintenance Manual for the GWTP. The O&M Manual provides the information necessary to operate and maintain the extraction and treatment facilities. The manual describes the overall systems; the anticipated groundwater characteristics; required effluent quality; and the process control, startup, normal operation, and shutdown of the equipment. The Contingency Plan portion of this document describes the procedures to be followed in case a spill or other discharge of waste materials or hazardous substances occurs during the course of operating and maintaining the GWTP.

Health and Safety procedures are not addressed in this manual. This plan is intended to be used in conjunction with the O&M manuals provided by the manufacturers of the equipment, and as such, it does not focus on routine maintenance and calibration of standard equipment items. Reference to the manufacturers' O&M manuals (includes Volumes 5 through 11) is made throughout this plan, and it is therefore imperative that the plant operator become familiar with those documents as well.

This O&M Manual and Contingency Plan for the GWTP are designed to provide the plant operator with proper background and procedures for day-to-day operation and maintenance of the treatment facility. The manual includes:

- An overall description of the extraction and treatment facilities
- A detailed description of the major extraction and treatment components and support systems
- Individual equipment descriptions, identifying major components, procedures, process control provisions (where applicable); a trouble-shooting guide; and preventive maintenance information
- A sampling and analytical program and a method of record keeping and reporting
- An Emergency Response and Contingency Plan

It should be emphasized that specific maintenance information on each piece of equipment is provided in the equipment manufacturers' O&M manuals included in Volumes 5 through 11 of this manual.

1.1.1 Operations and Maintenance Manual Revision Notes

This manual was developed to incorporate the upgrades added to the GWTP in the spring of 2000 and is to be used in conjunction with the original manual entitled "Operations and Maintenance Manual for the Perimeter Ground Water Containment System and the Barrier Wall and Associated Extraction System" dated July 1997. Following is a summary of the changes to the original manual:

- This Volume 1 replaces the original July 1997 Volume 1 entitled "Operations and Maintenance Plan/Contingency Plan for the PGCS and BWES."
- Volume 4A, containing the as-builts for the GWTP upgrades, has been added.
- Volume 9, containing equipment manufacturers' manuals for new equipment, has been added.
- Volume 10, containing additional equipment manufacturers' manuals for the activated sludge plant and the Catalytic Oxidizer/Scrubber, has been added.
- Volume 11, containing the programmed ladder logic for the upgraded system and program output and reference files, has been added.

There are no other changes to the original manual.

1.2 EXTRACTION AND TREATMENT REQUIREMENTS

From 1997 until completion of the upgrades, the existing GWTP was used to treat groundwater collected from the PGCS and groundwater from the BWES. Influent from the BWES was limited to flowrates sufficient to maintain the groundwater level in the containment area (On-Site Area and Off-Site Area) at a level that would not overflow the barrier wall. During implementation of the Final Remedy, additional influent streams have been generated requiring treatment by the GWTP. New influent streams have been generated due to new equipment and extraction wells, the installation of a separation barrier wall between the On-Site and Off-Site Areas, and segregation of the BWES extraction wells by location. These influent streams have been or will be generated by the following Site activities and sources:

- The lowering of the water table in the Off-Site Area by approximately 8 feet to allow more effective operation of the in-situ soil vapor extraction (ISVE) system that has been installed in the Off-Site Containment Area (OFCA) and the Kapica-Pazmey Area (K-P Area);

- ISVE condensate collected in the knockout tanks of the ISVE systems that has been installed in the OFCA and the K-P Area;
- The lowering of the water table in the On-Site Area by approximately 5 feet to allow more effective operation of the ISVE system that will be installed in the Still Bottoms Pond Area (SBPA);
- ISVE condensate will be collected in the knockout tank of the ISVE system that will be installed in the SBPA; and
- Continued operation of the PGCS.

1.2.1 Extraction Requirements

The design hydraulic capacity of the treatment system is based on flow contributions from the following major sources of contaminated water:

1. The seven extraction trenches (EW-11, EW-12, EW-13A, EW-15, EW-16, EW-19, and EW-20) in the Off-Site Area;
2. ISVE condensate from the OFCA and K-P Area ISVE systems;
3. The three extraction trenches (EW-10, EW-17, and EW-18) in the On-Site Area;
4. Additional extraction wells to be installed in the On-Site Area;
5. ISVE condensate from the SBPA ISVE system; and
6. The PGCS.

Because there are several sources of water that will have high flows for a short period of time and lower flows once steady-state conditions are reached, it is necessary to utilize the schedule proposed for the Final Remedy for sequencing the activities so that the most appropriate treatment system could be designed and operated to meet the project's objectives. The schedule for startup and operation of each of the water-producing activities and the resulting estimated flows to the GWTP is presented in Table 1-1. The schedule is based on the following operational strategy:

Stage 1: Stage 1 commenced upon completion of installation of the separation barrier wall, ISVE systems in the Off-Site Containment Area and K-P Area, and the clay cover in the Off-Site Area. At this time, dewatering of the Off-Site Area and ISVE system operation (including condensate collection) began. Maintenance dewatering in the On-Site Area and groundwater collection by the PGCS has continued. Stage 1 is expected to last for up to one year. The estimated total maximum flow during this stage is 59 gallons per minute (gpm), and the estimated minimum flow during this period is approximately 37 gpm.

Stage 2: Stage 2 will commence when dewatering of the Off-Site Area is complete. At this time, dewatering of the On-Site Area will begin. Maintenance dewatering in the Off-Site Area (maintaining the groundwater constantly at the lowered water level), operation of the ISVE systems in the OFCA and K-P Areas (including condensate collection), and groundwater collection by the PGCS will continue during this stage. Stage 2 is expected to last for approximately eight months. The estimated total maximum flow during this stage is 61 gpm, and the estimated minimum flow during this period is approximately 39 gpm.

Stage 3: Stage 3 will commence when dewatering of the On-Site Area is complete. At this time ISVE system operation in the Still Bottoms Pond Area (including condensate collection) will begin. The following will continue: maintenance dewatering in the Off-Site and On-Site Areas (at the lowered groundwater level), operation of the ISVE systems in the OFCA and K-P Areas (including condensate collection), and groundwater collection by the PGCS. The estimated total maximum flow during this stage is 50 gpm and the estimated minimum flow during this period is approximately 18 gpm.

Based on the estimated flows presented in Table 1-1, the treatment system was sized for a maximum hydraulic capacity of 60 gpm. A maximum design flowrate of 60 gpm was selected due to the maximum capacities of some of the existing equipment. A design flowrate of 60 gpm provides sufficient capacity to treat the maximum flows expected during dewatering of the Off-Site Area (Stage 1) and On-Site Area (Stage 2). The long-term flow to the treatment system is estimated to be 50 gpm (Stage 3).

1.2.2 Expected Groundwater Characteristics

During design of the upgrades, two influent profiles were developed for each of the flow conditions (Stages 1 through 3) shown in Table 1-1. The profiles provided flow-weighted averages for contaminant loading of the treatment system based on projected maximum and minimum hydraulic loading scenarios. Review of the profiles indicated that high contaminant concentrations in the SBPA and OFCA would result in highly contaminated flows from the ISVE condensate collection systems and new extraction trenches/wells installed as part of the Final Remedy. These two source-types of high contaminant concentration significantly impact the quality of the influent.

To provide for the potential for highly variable influent characteristics, the following provisions were incorporated in the design of the GWTP:

1. Influent from the ISVE condensate collection systems, interior extraction trenches and wells in the OFCA and On-Site Containment Area (ONCA), and other sources containing free product are or will be pretreated using a gravity phase separation tank (T-101) and the existing oil/water separator (ME-1). The purpose of this additional treatment is to separate free phase products such as oil and grease and other organic matter from the aqueous-phase groundwater.

2. Following pretreatment of the high strength flows, groundwater from all sources at the Site is combined in an aerated equalization tank (T-102). The dissolved volatile organic compounds (VOCs) in the groundwater are stripped in the aeration tank and the off-gases are treated by catalytic or thermal oxidation (ME-106 or ME-205). The remaining organic compounds such as semi-volatile organic compounds (SVOCs) and residual VOCs are removed in a biological treatment system (ME-101). These remaining organic compounds were calculated as a function of biological oxygen demand (BOD) and chemical oxygen demand (COD) to design the biological treatment system.
3. Additional flows exhibiting the worst case contaminant loadings were added to the influent design scenarios as a factor of safety.
4. Flexibility was provided to allow for effective treatment during minimal hydraulic and contaminant loadings projected to occur during each of the three operating stages.
5. The groundwater extraction trenches are equipped with local controllers, sample ports, and flow meters to monitor the influent from each extraction point and adjust pumping rates as necessary to keep the GWTP within design hydraulic and contaminant loading limits.

Based on the above provisions, design influent contaminant profiles were developed for each stage in the treatment process. These profiles were based on flow-weighted contaminant concentrations from the different sources and the expected contaminant removal in each stage of the treatment process. The expected contaminant removal was determined in the full-scale treatability study conducted from July 1998 through November 1998. The design influent profiles are presented in Table 1-2.

1.2.3 Effluent Quality Criteria

In accordance with the Record of Decision (ROD), treated effluent from the treatment system is discharged to the adjacent wetlands. Although a discharge permit is not required, the substantive requirements of a permit, such as effluent standards, need to be met. For discharges to the wetlands at the ACS Site, Indiana Department of Environmental Management (IDEM) has issued the effluent limits presented in Table 1-3. In addition to the requirements listed in Table 1-3, the following conditions must be satisfied:

- The discharge shall not cause excessive foam in the receiving waters/areas. The discharge shall be essentially free of floating and settleable solids.
- The discharge shall not contain oil or other substances in amounts sufficient to create a visible film or sheen on the receiving waters/areas.

- The discharge shall be free of substances that are in amounts sufficient to be unsightly or deleterious or which produce color, odor, or other conditions in such a degree as to create a nuisance.
- The discharge shall not contain any substance in any amount sufficient to be acutely toxic to, or to otherwise severely injure or kill aquatic life, other animals, plants, or humans.
- The discharge shall not contain any substances or combinations of substances in amounts that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly or otherwise impair the designated use.
- There shall be no debris discharge. Debris is defined as woody material such as bark, twigs, branches, heartwood or sapwood that will not pass through a 1.0-inch diameter round opening and is present in the discharge from a wet storage facility.

1.2.4 Air Emissions

Although no IDEM permit is required for air emissions control because the GWTP is part of a National Priority List (NPL) Site, the GWTP provides adequate controls to prevent venting potentially toxic vapors into the treatment building or to the atmosphere. Specific information on the air emissions limitations and monitoring requirements are included in Volume 2 (Performance Standard Verification Plans (PSVP)) and revised in the Quality Assurance Project Plan (QAPP) (MWH, November 2001). A summary is included in Section 6 of this manual.

1.2.5 Residuals Management

The GWTP generates five types of residuals: (1) non-aqueous phase liquids (NAPL), (2) primary sludge, (3) waste activated sludge, (4) spent carbon, and (5) scrubber blowdown. Until notified otherwise by the United States Environmental Protection Agency (U.S. EPA) or the ACS Technical Committee, all of the materials are managed as an F-listed hazardous waste.

- **NAPL.** Screening analysis results of the NAPL are used to determine the ultimate disposal method for the NAPL.
- **Primary Sludge.** The sludge from the gravity phase separator (T-101), Corrugated Plate Interceptor (CPI) oil/water separator (ME-1), and lamella clarifier (ME-6) is analyzed to determine if it can be landfilled in a Resource Conservation and Recovery Act (RCRA) Subtitle C (hazardous waste) landfill or if it needs to be incinerated. The analytical results are compared to the Treatment Standards in 40 Code of Federal Regulations (CFR) 268.40 Subpart D to make this determination.

- **Waste Activated Sludge.** The sludge from the activated sludge plant (ME-101) is analyzed to determine if it can be landfilled in a RCRA Subtitle C (hazardous waste) landfill, used in landfarming applications, or if it needs to be incinerated. The analytical results are compared to the Treatment Standards in 40 CFR 268.40 Subpart D to make this determination.
- **Spent Carbon.** The spent carbon is returned to the carbon supplier for regeneration and future use.
- **Scrubber Blowdown.** Currently, the scrubber blowdown from ME-106 is recycled into tank T-101 to assist in lowering the pH of the process stream. The lower pH will result in more efficient removal of oil and grease in ME-1 and will decrease the amount of sulfuric acid being added to T-103 to also lower the pH process stream prior to ME-1 for treatment. Additional options will be considered in the future as needed.

2.0 PROCESS AND CONTROL DESCRIPTIONS

The treatment system of the GWTP contains the components necessary to provide for flow equalization, free-phase product removal, emulsified product removal, organics removal and destruction, metals removal, solids removal, solids handling, disinfection, and air emission control. A block diagram of the process illustrating the major treatment units is shown on Figure 2-1.

Highly contaminated groundwater from the On-Site and Off-Site extraction wells and trenches; and ISVE condensate collection systems are pumped directly to a gravity phase separation tank (T-101) for removal of free phase materials (NAPLs) (i.e. organic constituents that are present above their solubility limit) and heavier suspended solids. Effluent from separation tank flows by gravity through a mixing tank (T-103) to the Corrugated Plate Interceptor (CPI) oil/water separator (ME-1) for removal of emulsified oils and other NAPLs not removed in the gravity phase separation tank. A de-emulsifying agent is added in the mixing tank and the pH is lowered to approximately 4.0 standard units (S.U.) to contact emulsified oils and other NAPLs. Effluent from the CPI oil/water separator flows by gravity to the aerated equalization tank (T-102).

Low-strength groundwater from the PGCS and less contaminated Off-Site and On-Site extraction trenches/wells is blended with effluent from the CPI oil/water separator for pH adjustment, mixing and aeration in the aerated equalization tank (T-102). The aeration system removes COD, BOD, VOCs, SVOCs, and oxidizes and precipitates metals for removal in the lamella clarifier (ME-4, ME-5, ME-6). The system also blends flows from the various sources to equalize the contaminant loading on downstream processes.

The effluent from the aerated equalization tank (T-102) is pumped to the lamella clarifier (ME-6) to remove suspended solids and precipitated metals. Effluent from the lamella clarifier is pumped to a package activated sludge system (ME-101) to remove COD, BOD, trace VOCs, and SVOCs by biodegradation. This package unit contains two aerated bioreactor zones with an established biomass (mixed liquor suspended solids (MLSS)), a clarifier for separation of the MLSS, and two aerobic sludge digesters for storing and processing waste activated sludge. Effluent from the activated sludge system flows through the upflow sand filter (ME-7) to capture any residual particulate matter that escapes clarification. Following sand filtration in ME-7, the groundwater is polished to remove residual contaminants using the sand filter beds (ME-8 and ME-9), granular activated carbon (GAC) systems (ME-33 and ME-34), and ultraviolet oxidation (UV-OX)(ME-2) for disinfection. The pH of the groundwater exiting the final GAC unit is adjusted, if needed, to within the permit-required range of 6 to 9 S.U. and discharged to the wetlands.

The treatment process combines several different physical, chemical, and biological processes to remove both organic and inorganic components from the groundwater.

The system consists of the following major treatment components:

- Gravity Phase Separator (T-101);
- CPI Oil/Water Separator (ME-1);
- Aerated Equalization Tank (T-102) with off-gas treatment (ME-106);
- Lamella Clarifier (ME-6) with Rapid Mix Tank (ME-4), and Flocculation Tank (ME-5);
- Activated Sludge Reactor, Clarifier, and Aerobic Sludge Digester (ME-101);
- Upflow Sand Filter (ME-7));
- UV-Oxidation Unit (ME-2);
- Pressure Sand Filter Beds (ME-8 and ME-9);
- Granular Activated Carbon Units (ME-33 and ME-34);
- Effluent pH Adjustment;
- Organic Sludge Storage and Thickening (T-104 and T-1);
- Inorganic Sludge Storage and Thickening (T-5 and T-4); and
- Sludge Dewatering (ME-12).

Each of the individual process units described in this section is shown on Figure 2-1. The layout of the treatment system within the GWTP building is shown in Figure 2-2. A summary of the design hydraulic and contaminate loadings for each treatment component is shown in Table 2-1.

2.1 BARRIER WALL EXTRACTION SYSTEM

Process Description

The BWES extraction system consists of a series of extraction trenches and dual-phase extraction wells. The original BWES consisted of eight 100 feet long extraction trenches ranging in depth from 16 feet to 25 feet (EW-10, EW-11, EW-12, EW-13, EW-15, EW-16, EW-17, and EW-18). As part of the implementation of the Final Remedy two new extraction trenches (EW-19 and EW-20) were installed and EW-13 was repaired. EW-19 is a 150-foot long trench installed just south of EW-15 and EW-20 is an approximately 260-foot long trench installed just south of the railroad tracks dividing the On-Site Area

and Off-Site Area. Also, as part of the final remedy, twenty-one dual-phase extraction wells will be installed in the SBPA as part of the ISVE system in that area for additional groundwater collection. The locations of the collection trenches are shown on Figure 2-3.

Each extraction trench has a sump at one end that has an in-ground vault for access. There is a pneumatic or electric submersible pump in each sump. Each pump has a local controller located at each well. Each pump can also be controlled from the GWTP. Extraction trench 20 consists of four extraction wells EW-20, EW-20A, EW-20B, and EW-20C. The primary pumping sources for extraction trench 20 are EW-20 and EW-20C, located at either end of the trench. EW-20C is constructed similarly to the other extraction wells and is a "wet well," consisting of a 48" diameter concrete vault. It is equipped with the same submersible electric pump as the other wells. Operation of the wells is continuously evaluated and adjusted based on well conditions.

The trenches and extraction wells are grouped based on location to create five separate influent lines to the GWTP from the BWES (see Table 2-2). When dual-phase extraction wells are later added in the SBPA, they will be combined to form one new separate influent line. These groupings allow the operator to better control the hydraulic and contaminant loading to the GWTP. Also, sample ports and local pump controllers are in each extraction trench vault to provide additional control and monitoring.

The purpose of the BWES extraction system is to maintain the water table within the barrier wall at a level that will not overtop the wall and subsequently potentially contaminate the surrounding area. The BWES is also used to dewater the Off-Site Area and On-Site Area during implementation of the Final Remedy to allow operation of the ISVE systems that have been or will be installed in each area.

As the BWES trenches dewater the areas within the barrier wall, the amount of groundwater extracted is expected to gradually decrease and the contaminant concentrations may increase. Initially the influent flowrates from the BWES, PGCS, and ISVE condensate collection systems may be close to the maximum hydraulic loading of the GWTP. Toward the end of each dewatering stage and during long-term maintenance dewatering, the contaminant loading may approach the maximum design contaminant loading of the GWTP. Consequently, the extraction rate from some of the influent sources will need to be monitored and potentially reduced at the local pump controllers to most effectively control the influent characteristics to the GWTP. Groundwater from the ISVE condensate collection systems and highly contaminated BWES wells/trenches should be routed through the gravity phase separator (T-101) and CPI oil/water separator (ME-1) prior to discharge into the aerated equalization tank (T-102). Groundwater from the PGCS and less contaminated BWES wells/trenches should be routed directly to T-102, bypassing free-product removal. The flowrate of the water entering T-101 needs to be closely monitored because the design flowrate through the free-product removal portion of the GWTP is 30 gpm.

Control Description

Each of the existing BWES extraction sumps is equipped with a submersible electric pump. These pumps are single phase, 240-volt electrical pumps that are locally controlled by “Motor Minder” control units located at each extraction well. The local “Motor Minders” monitor the voltage and amperage draw of its corresponding pump and engage/disengage the pump based on variances in these parameters. As the water level drops below the inlet of the pump, the amperage in the pump drops and the “motor minder” turns the pump off. After a given time interval, pre-set by the operator, the “motor minder” turns the pump on again (32 minutes is the typical value).

A power transformer, 120 volt outlet, and disconnect switch are located in the panel with the “Motor Minder”. The Power transformer steps the three-phase, 480 volt power feed down to single phase, 220 volt power for the pumps and single phase, 120 volt power for the outlet.

The electric pumps are expected to be continuously active. A pump will stop if the power supply is shut down for maintenance or due to a system-wide power outage, if water level drops below the pump or if a system shutdown alarm is activated. Power will be restored when the alarm/failure conditions have been corrected and when the water level in Tank T-102 is below the enable set point for the BWES pumps (LL5-102) (adjustable).

The combined influent line from the BWES extraction trenches has a flow meter and transmitter (FE/FIT-108) with instantaneous and totalized flow indication. The flow measurements can be read on the unit itself, but the flow data are also sent to the main PLC for tracking.

2.2 PERIMETER GROUNDWATER CONTAINMENT SYSTEM

Process Description

The PGCS extraction system consists of a 14-foot deep by 1300-foot long extraction trench with three extraction sumps. The extraction trench was constructed using the “single-pass” trencher method and, as a result, it actually consists of three separate trench legs that overlap slightly. Each sump is located at the northern most end of the trench legs. An electric submersible pump is located in each sump (EP-19, EP-20, and EP-21) and all three pumps discharge into a common 2-inch diameter HDPE pipeline that conveys water to the treatment building. All the discharge pipes are buried for frost protection; therefore, pitless adapters were installed on the sump casings to allow for removal of the extraction pumps, if needed.

Because the purpose of the PGCS extraction system is to contain contaminated groundwater before it leaves the site, the system only needs to lower the water table at the trench by about 2 to 4 feet (water level monitoring will confirm this). Based on historic groundwater level data, this has been shown to be sufficient to change the existing groundwater flow direction and control the migration of contaminated water. With this in

mind, the extraction pipe in the PGCS trench was placed about 2 to 4 feet off the bottom of the trench.

Because the PGCS pumps are constant speed, a valve was installed on the discharge line of each pump to allow the throttling back of flow. Groundwater extracted from the PGCS trench is routed directly to tank T-102 by opening and closing the respective valves on the influent header located inside the treatment building.

Control Description

Each of the electric submersible PGCS extraction pumps is automatically controlled by the main PLC and a level transmitter located in each of the sumps. The level transmitter sends a 4-20 mA signal to the main PLC. The PLC then sends a signal to the pump's motor starter which is located in the motor control center (MCC) in the electrical room. The water level in each extraction sump is also displayed on the computer screen. Each pump is enabled (i.e., the pump is turned on) when the water level within its sump rises above 628 feet (United States Geological Society (USGS) scale) and the level in tank T-102 is below its low level set point (adjustable parameter, typically 190 inches). The low level set point for EP-19 is designated as LL2-102, the low level set point for EP-20 is designated as LL3-102, and the low level set point for EP-21 is designated as LL4-102. When the water level in the extraction sump drops below 624 feet (USGS scale) or tank T-102 is above its low level set point (adjustable parameter, typically 204 inches) or if one of the various process alarms is activated, the pump operation is disabled (i.e., the pump is shut off). The high level set point for EP-19 is designated as LH2-102, the high level set point for EP-20 is designated as LH3-102, and the high level set point for EP-21 is designated as LH4-102. If the water level in T-102 rises above the high level set point for a particular PGCS pump, that pump will not re-engage until the water level drops below the low level set point for that pump.

If the water level in the extraction sump rises above a user defined high-high level of 633 feet (USGS scale), an alarm is issued at the man-machine interface (MMI) (operator's control computer) indicating a submersible pump failure. The idea of this alarm is to set the high-high level in the sump at an elevation below the normal water table level. If the pump cannot keep the water level in the sump depressed below this point, it means the pump has failed. For startup after extended periods of shutdown, the high-high level should be set at 633 feet because this is the typical water table elevation in the vicinity of the trench. The operator will need to change this value as the trench begins to dewater the area and the general water table elevation drops.

Each pump has a Hand-Off-Auto (HOA) switch located on the MCC so it can be turned off or operated manually. The computer screen also has a HOA switch which can be used to operate the pumps manually by clicking on "Hand". In manual "Hand" operation, the low level shut off does not stop the pump, so it is important to monitor the water level to ensure that the pump is not running dry. An elapsed time meter and a cycle counter are also located on each pump's motor starter to indicate the number of pump starts and the associated total run time. The operator needs to review this information to assess whether

or not the pumps are cycling on and off too frequently. If so, the valve on the pump's discharge needs to be throttled back.

The combined influent line from the PGCS extraction trenches has a magnetic flow meter (FE/FIT-802) with instantaneous and totalized flow indication.

2.3 IN-SITU SOIL VAPOR EXTRACTION CONDENSATE COLLECTION SYSTEM

Process Description

There will be two ISVE systems installed within the barrier wall as part of the Final Remedy. The first, which has already been installed and is in operation, has wells in the OFCA and K-P Area with the blower building located in the OFCA. The second will be installed in the SBPA Area. Each of these areas is or will be equipped with a condensate collection and transfer system that consists of a demister, a condensate storage tank, and a transfer pump. Moisture that is removed from the ground by the extraction system will be removed from the vapor by the demister and will drain to the condensate storage tank. These tanks will be equipped with a high level switch, low level switch, and a high-high level switch. The high and low level switches will engage/disengage the transfer pumps. These pumps will pump the condensate to the GWTP for treatment. The high-high level switch will activate an alarm that will notify the operator and shutdown the ISVE system.

Control Description

The ISVE systems will operate fairly independently of the GWTP except for the condensate collection and transfer systems. Each condensate collection and transfer system consists of a demister, a condensate storage tank, and a transfer pump. The demisters will remove moisture from the extracted vapor and discharge it to the condensate storage tank for that ISVE system. These tanks will be equipped with a high level switch, low level switch, and a high-high level switch. The high and low level switches will enable/disable the transfer pumps. These pumps will pump the condensate to the GWTP for treatment. The high-high level switch will activate an alarm that will notify the operator and shutdown the ISVE system. The transfer pumps will be interlocked to the GWTP and will be disabled if an alarm is activated at the GWTP that shuts off the influent sources. The transfer pumps will also be controlled by the water levels in the aerated equalization tank (T-102). The ISVE transfer pumps will be enabled when water drops below the low level set point (operator adjustable, designated as LL7-102) and disabled if the water level in T-102 rises above the high set point (operator adjustable, designated as LH7-102). The set points will be "latched" so that if the water level rises above LH7-102, the pumps will not be re-engaged until the water level drops below the low level set point (LL7-102).

In addition to the interaction between the condensate collection and transfer systems and the GWTP, several operating parameters of the ISVE systems will be monitored at the GWTP MMI. This manual will be either revised when installation of the ISVE systems is

complete to incorporate these additions or a new O&M manual will be developed specifically for the ISVE systems.

2.4 GROUNDWATER TREATMENT PLANT INFLUENT HEADER SYSTEM

Process Description

Initially the groundwater treatment system treated groundwater from two influent lines. One line collected water from the PGCS and the second line collected water from the BWES. Groundwater from the PGCS was pumped by the field pumps directly to the aerated equalization tank (T-102). The flowrate for this influent was monitored by a flowmeter (FM-802).

Initially all of the extraction wells from the BWES were headered together in the field and entered the treatment building in one pipe. Water within this pipe was pumped by the field pumps to either the gravity phase separator (T-101) or combined with the influent from the PGCS and discharge to aerated equalization tank (T-102). The BWES influent flowrate was monitored by flowmeter FM-108 and the combined PGCS/BWES influent flowrate was monitored by flowmeter FM-109.

In July 2001 an influent header system for the BWES and ISVE condensate lines was completed. Each of the individual influent lines is equipped with a flowmeter (FM-101 through FM-107), a sample port, and valving to allow the influent from each pipe to be directed to T-101 or to combine with the PGCS influent for discharge into T-102. A summary of the influent lines is shown in Table 2-2.

A summary of the flowmeters and their corresponding monitoring point is summarized below:

Flowmeter	Monitoring Point
FM/FIT-101	Influent from BWES extraction wells EW-10, EW-17, & EW-18
FM/FIT-102	Influent from the SBPA extraction wells
FM/FIT-103	Influent from BWES extraction wells EW-11, EW-12, & EW-13A
FM/FIT-104	Influent from BWES extraction wells EW-11, EW-12, EW-13A, & EW-20
FM/FIT-105	Influent from BWES extraction wells EW-15, EW-16, & EW-19
FM/FIT-106	Influent from the OFCA and K-P ISVE condensate pipe
FM/FIT-107	Influent from the SBPA ISVE condensate pipe
FM/FIT-108	Influent to T-101
FM/FIT-109	Combined influent from PGCS, BWES, & ISVE systems
FM/FIT-802	Influent from the PGCS

Control Description

Flowmeters/transmitters FM/FIT-101 through FM/FIT-107 measure the instantaneous and total flowrate through each of the influent pipes from the BWES and ISVE systems and transmits the flowrates (total and instantaneous) to the PLC for monitoring by the operator at the MMI. The flowrates are transmitted to the PLC by 4-20 mA signals.

Flowmeter/transmitter FM/FIT-802 measures the instantaneous and total flowrate of the influent from the PGCS and transmits the flowrate (total and instantaneous) to the PLC for monitoring by the operator at the MMI. The flowrate is transmitted to the PLC by a 4-20 mA signal.

Flowmeter/transmitter FM/FIT-108 measures the instantaneous and total flowrate of the T-101 influent and transmits the flowrate (total and instantaneous) to the PLC for monitoring by the operator at the MMI and to pace de-emulsifier addition to T-103 by the pacemaker pump P-107. The flowrate is transmitted to the PLC by a 4-20 mA signal. Flowmeter/transmitter FM/FIT-109 measures the instantaneous and total flowrate of the combined influent from the PGCS and BWES and transmits the flowrate (total and instantaneous) to the PLC for monitoring by the operator at the MMI. The flowrate is transmitted to the PLC by a 4-20 mA signal.

2.5 GRAVITY PHASE SEPARATION TANK (T-101)

Process Description

Separation of solids and NAPLs is accomplished using a 38,000-gallon, stainless steel gravity separation tank (T-101) with sufficient holding time (approximately 20 hours at 30 gpm) to allow phase separation. The recovered light NAPL (LNAPL) is decanted from the top of the water and flows by gravity to the oil storage tank (T-6) for off-site disposal. The separation tank is equipped with multiple decant ports to remove layers of LNAPL. The LNAPL discharge line contains a sight glass and sample port to determine the correct level to draw-off the LNAPL. Solids that settle in the separation tank are pumped by sludge pump P-101 to the sludge holding tank (T-5) for thickening, dewatering, and suitable off-site disposal. The sludge pump operates off a timer set by the operator at the MMI or by manual operation based on sludge accumulation. If dense NAPL (DNAPL) is separated in T-101, it is pumped to the oil storage tank (T-6) using the sludge pump (P-101). The sludge pump piping is configured to allow pumping to both tanks T-5 or T-6 with tank T-5 as the primary. However, solids removed from T-101 are often coated with organic matter.

Control Description

The sludge pump (P-101) which is used to transfer collected sludge to the sludge holding tank (T-5) or to the oil storage tank (T-6) is driven by compressed air from air compressor ME-24. The air supply to the pump is controlled by a solenoid valve that operates based on an adjustable timer in the PLC. The operator controls the timer at the MMI by entering the desired pumping frequency and duration. This timer can be overridden by HOA switches

located at the pump and the MCC or upon a high level in sludge holding tank T-5 (LAH-5). The run status of the pump is monitored at the alarm panel (RUN-P101) and the MMI. P-101 can be manually operated by turning either of the HOA switches to "Hand" mode.

The tank is equipped with a high level switch (LSH-101) that transmits a signal to the PLC to activate an alarm (LAH-101) and disengage the influent field pumps and recycle pump P-101 upon a high water level in T-101. LAH-101 requires operator acknowledgement to deactivate and return system to normal operation.

2.6 MIXING TANK (T-103)

Process Description

Effluent from the gravity phase separation tank (T-101) flows by gravity through a 1,000-gallon, stainless steel mixing tank (T-103) prior to entering the CPI oil/water separator. De-emulsifier is added and the pH is lowered to 4 S.U. (or as determined otherwise). The de-emulsifying agent addition rate is adjusted by a Stranco pacemaker (P-107) that is regulated by a flow meter (FM-108) located at the influent of the gravity phase separation tank. The pH adjustment system adds sulfuric acid (via metering pumps P-18) to the groundwater to adjust the pH to the level set by the operator at the MMI. The sulfuric acid addition rate is regulated by a pH sensor (CE-103) located in the mixing tank. T-103 is equipped with an electric mixer for mixing (ME-109). The addition of de-emulsifying agent and acid to the influent stream of the CPI oil/water separator assists in the separation and removal of emulsified oils and other NAPLs by the coalescing plates in the oil/water separator.

The pH sensor is equipped with an automatic washing system that washes the sensor with a potable water stream. The frequency and operating duration of the automatic washing system is controlled by the operator at the MMI or by the local HOA switch (HS-103).

Control Description

Mixing tank (T-103) receives effluent from the gravity phase separation tank (T-101). In order to facilitate separating emulsified oils from the groundwater, the pH of the groundwater in T-103 is lowered to approximately 4 S.U. (or as set by the operator at the MMI), through the addition of sulfuric acid to the contents of tank T-103. A pH sensor/controller (CE-103/CIC-103) controls sulfuric acid addition to T-103 by transmitting a 4-20 mA signal to the PLC (the set points for the 4-20 mA signal and corresponding PID loop are set by the operator at the MMI). The PLC activates the acid metering pump (P-18) when the pH level is above the pH set point. The operator also inputs a high pH level and low pH level at the MMI. The PLC also activates the high pH alarm (CAH-103) if the pH rises above the high pH level and activate the low pH alarm (CAL-103) if the pH drops below the low pH level. These alarms are activated at the alarm panel and at the MMI. The actual pH level needs to be monitored at the MMI on a continual basis and the run status of the metering pump is monitored at the MMI and PLC alarm panel (RUN-P18).

The pH sensor (CE-103) is equipped with an automatic washing system that washes the sensor with a stream of potable water. The frequency and operating duration of the automatic washing system is controlled by the operator at the MMI. The PLC opens and closes solenoid valve SV-103 to control the potable wash water stream. SV-103 can also be controlled by a local HOA switch (HS-103). In “Hand” mode, SV-103 is opened; in the automatic operating mode (“Auto”), SV-103 is controlled by the PLC; and in “Off” mode, SV-103 is closed.

A Stranco Pacemaker feed pump (P-107) injects a de-emulsifying agent/potable water mixture into T-103. The de-emulsifier injection rate is controlled feed by pump P-107 and adjusted proportionally to the groundwater influent flowrate into T-101 as measured by flowmeter FM-108 and transmitted by a 4-20 mA signal though the PLC to the feed pump. The operating status of P-107 is monitored at the MMI and PLC alarm panel (RUN-P107)

The mixer in mixing tank T-3 (ME-109) is controlled by an on/off switch built into the mixer.

2.7 CORRUGATED PLATE INTERCEPTOR OIL/WATER SEPARATOR (ME-1)

Process Description

The CPI oil/water separator separates free oils and other free-phase products and solids from the groundwater stream. The recovered emulsified oils, light NAPL (LNAPL), and other organic phase material are removed from the top of the water by an overflow weir and flows by gravity to the oil storage tank (T-6).

Solids that settle out in the CPI oil/water separator are pumped by sludge pump P-12 to the sludge holding tank (T-5) at timed intervals set by the operator at the MMI or by manual operation based on sludge accumulation. The sludge effluent line will be equipped with a sample port and piping/valving configuration to allow the operator to pump dense NAPL (DNAPL) to the oil storage tank T-6. Effluent from the CPI oil/water separator will flow by gravity to the aerated equalization tank (T-102).

Control Description

The CPI oil/water separator does not have any instrumentation or control associated with it. The sludge pump (P-12), which is used to transfer collected sludge to the sludge holding tank (T-5) or to the oil storage tank (T-6), will be driven by compressed air from air compressor ME-24. The air supply to the pump will be controlled by a solenoid valve that will operate based on an adjustable timer in the PLC. The operator will control the timer at the MMI by entering the desired pumping frequency and duration. This timer can be overridden by HOA switches located at the pump and the MCC and upon a high level in sludge holding tank T-5 (LAH-5). The run status of the pump will be monitored at the alarm panel (RUN-P12) and the MMI. P-12 can be manually operated by turning the either of the HOA switches to “Hand” mode.

2.8 AERATED EQUALIZATION TANK (T-102)

Process Description

The aerated equalization tank receives the effluent from the pretreatment system, groundwater from the less contaminated Off-Site and On-Site extraction trenches and wells, and groundwater from the PGCS. Equalization and blending of the individual influent sources is achieved by mixing the tank contents with diffused air from a blower (ME-105). Blower ME-104 is also used as a backup by adjusting the valving at the blower header, but is not “interlocked” to the PLC. Equalization is necessary to provide a relatively constant contaminant mass loading to the downstream components of the treatment processes. The diffused air also strips the majority of the VOCs from the water, and as a result, removes BOD and COD, and oxidizes and precipitates iron and other metals. Ten hours of residence time provides equalization, mixing, and aeration in the influent streams at a flowrate of 60 gpm. The tank has a volume of 36,000 gallons and is 24 feet long, 12 feet wide, and has a depth of 20 feet (approximately 17-foot water depth plus a 3-foot freeboard). The design airflow rate is approximately 400 cubic feet per minute (CFM). A defoaming agent is added to the T-102 influent piping to decrease the amount of foaming in the tank due to aeration and groundwater characteristics. The defoaming agent addition rate is adjusted by a metering pump (P-108) that is regulated by the flow meter (FM-803) located at the effluent of the aerated equalization tank. Effluent from T-102 is pumped to the chemical precipitation unit (ME-4, ME-5, and ME-6) by variable frequency drive (VFD) pumps (P104 and P-105). The air exiting the equalization tank is contaminated with VOCs and is treated in a catalytic oxidation unit (ME-106) which destroys the VOCs. The VOC-free air is then vented to the atmosphere.

Control Description

T-102 is equipped with a level indicating transmitter (LE/LIT-102) to provide information for operating the influent pumps (P-104 and P-105), a coarse bubble air diffusion system which provides air (via blower ME-105) to mix the tank contents and remove contaminants, and a defoamer addition system.

The tank’s level indicating transmitter (LE/LIT-102) transmits the continuous tank level via a 4-20 mA signal to the PLC. The MMI is equipped with several operator controlled level set points that enable/disable various system components based on the water level in T-102. A summary of the components, set point identifiers, and operating logic is presented below:

- **P-104 and P-105.** Pumps P-104 and P-105 are disengaged when the water in T-102 drops below Low Level 1 (LL1-102) and engaged when the water level rises above High Level 1 (LH1-102). LH1-102 is “latched” to LL1-102 so that if the water level rises above LH1-102, P-104/P-105 continues to operate until the water level drops below LL1-102.

- **PGCS Pump EP-19.** Pump EP-19 is engaged when the water in T-102 drops below Low Level 2 (LL2-102) and disengaged when the water level rises above High Level 2 (LH2-102). LH2-102 is “latched” to LL2-102 so that if the water level rises above LH2-102, EP-19 will not operate until the water level drops below LL2-102.
- **PGCS Pump EP-20.** Pump EP-20 is engaged when the water in T-102 drops below Low Level 3 (LL3-102) and disengaged when the water level rises above High Level 3 (LH3-102). LH3-102 is “latched” to LL3-102 so that if the water level rises above LH3-102, EP-19 will not operate until the water level drops below LL3-102.
- **PGCS Pump EP-21.** Pump EP-21 is engaged when the water in T-102 drops below Low Level 4 (LL4-102) and disengaged when the water level rises above High Level 4 (LH4-102). LH4-102 is “latched” to LL4-102 so that if the water level rises above LH4-102, EP-19 will not operate until the water level drops below LL4-102.
- **BWES Wells EW-10, EW-17, and EW-18.** These pumps are engaged when the water in T-102 drops below Low Level 5 (LL5-102) and disengaged when the water level rises above High Level 5 (LH5-102). LH5-102 is “latched” to LL5-102 so that if the water level rises above LH5-102, the pumps will not operate until the water level drops below LL5-102.
- **BWES Wells EW-11, EW-12, EW-13A, EW-15, EW-16, EW-19, and EW-20.** These pumps are engaged when the water in T-102 drops below Low Level 6 (LL6-102) and disengaged when the water level rises above High Level 6 (LH6-102). LH6-102 is “latched” to LL6-102 so that if the water level rises above LH6-102, the pumps will not operate until the water level drops below LL6-102.
- **ISVE Condensate Transfer Pumps.** These pumps engage when the water in T-102 drops below Low Level 7 (LL7-102) and disengage when the water level rises above High Level 7 (LH7-102). LH7-102 is “latched” to LL7-102 so that if the water level rises above LH7-102, the pumps will not operate until the water level drops below LL7-102.
- **Recycle Pumps P-9 and P-10 and Level Alarms (LAH-102 and LAL-102).** The permissive for these pumps will be removed if the water drops below LL8-102 and rises above LH8-102. A high level alarm (LAH-102) will be engaged when the water level rises above High Level 8 (LH8-102). A low level alarm (LAL-102) will be engaged when the water level drops below Low Level 8 (LL8-102). Both alarms require operator acknowledgement to deactivate and return system to normal operation.

Pumps P-104 and P-105 are both equipped with variable frequency drives, so once the pumps are started, their speed is modulated by the PLC to maintain the flowrate that the operator inputs into the system via the MMI. Flowmeter/transmitter FM/FIT-803 measures the flowrate through the T-102 effluent piping and transmits the flowrate via a 4-20 mA signal to the PLC to confirm that the desired flowrate is being maintained. If the lead pump (either P-104 or P-105, as set by the operator at the MMI) cannot maintain the set flowrate, the lag pump is started. When the lag pump is started, the PLC automatically ramps down the lead pump speed to match lag pump speed, and the pump speeds are ramped up or down together. If both pumps drop below 30 hertz, indicating a reduced flow requirement, then the lag pump is stopped (first on--last off). Pumps P-104 and P-105 are alternated as lead pumps to equalize run time. When P-104 and P-105 are operated in "Hand" mode, they are operated at the speed set at the MMI. If the tank level drops below Low Level 1 (LL1-102), then P-104 and/or P-105 are disengaged. These pumps are disengaged upon shutdown or failure of blower ME-105 or upon activation of any alarms from process components downstream of T-102. The run status (on/off) of each pump is monitored at the MMI and the PLC alarm panel (RUN-P104 and RUN-P105) and the speed of each pump is continuously monitored at the MMI and at the MCC.

A 400-SCFM, positive displacement blower (ME-105) provides air for the coarse bubble diffusion system. The air discharge pipe of the blower contains a low air pressure indicating switch (PS-105) that activates an alarm (PAL-105) at the MMI, PLC alarm panel and audible upon shutdown or failure of the blower. Upon low air pressure from ME-105, PS-105 relays a signal to the PLC. After an operator set delay period (the delay time has been set by the operator at the MMI), the PLC activates the alarm (PAL-105) and disables the field pumps (BWES, PGCS, and ISVE condensate pumps), the influent pumps (P-104 and P-105), the recycle pumps (P-9 and P-10), and catalytic oxidizer/scrubber (ME-106). Alarm PAL-105 requires operator acknowledgement to deactivate and return system to normal operation. Blower ME-105 also receives a signal from the PLC to disable upon shutdown or failure of the catalytic oxidizer/scrubber unit (ME-106).

Foam suppression in T-102 is accomplished by adding a defoamer to the T-102 influent. The PLC controls the defoamer metering pump (P-108) based on flowrate through flowmeter FM-803. The run status of the pump can be monitored at the MMI and PLC alarm panel (RUN-P108).

2.9 PROCESS FLOWRATE

The flowrate through the main portion of the GWTP is set by the operator at the MMI and the flowrate through the phase separation components (T-101, T-103, and ME-1) are set by manual adjustment of the influent valves in the influent header system. The desired flowrate through the main components of the GWTP is maintained by VFD pumps P-104 and P-105 and flowrate readings from flowmeter FM-803. See Section 2.8 for a more detailed control description. It is recommended that the treatment process be run as a continuous operation with as constant a flowrate as possible. Since the extraction pumps

operate in a cyclic mode, the flowrate to the GWTP is set at a flowrate slightly higher than the average daily flowrate from the PGCS and BWES extraction systems and ISVE condensate collections systems. In addition, the flowrate takes into account internal recycle streams. The following formula is used to determine the flowrate set point:

$$Q_{TOT} = Q_{PGCS} + Q_{BWES} + Q_{OFCA\ ISVE} + Q_{ONCA\ ISVE} + Q_{RECYCLE} + \sim 5\text{ gpm}$$

Where Q represents flowrate is in gallons per minute (gpm).

This flowrate is adjusted based on operating stage and the water levels within the barrier wall as the pumping rates from the BWES extraction trenches has decreased after initial drawdown.

The influent from the BWES and ISVE condensate can be pumped through T-101 and subsequent phase removal components or be pumped directly to T-102. The flow paths from these sources is manually controlled at the influent header system and in the field based on influent flowrates and contaminant loading. If the influent water from any source contains free product (oil, tar, LNAPL, DNAPL, etc.) or excessive suspended solids, it is directed through T-101 and subsequent phase removal components of the GWTP prior to combining with the rest of the influent flow. Please note that the maximum flowrate through T-101, T-103, and ME-1 is 30 gpm.

2.10 LAMELLA CLARIFIER (ME-6)

Process Description

Oxidized iron; other metals such as arsenic, cadmium, selenium, mercury, and zinc; and suspended solids in the effluent of the aerated equalization tank are removed in the chemical precipitation unit (lamella clarifier with rapid mix and flocculation tanks). The unit consists of a rapid mix tank (ME-4), a flocculation zone (ME-5), and a plate settler (lamella clarifier, ME-6) with an internal sludge thickener. The pH of the influent stream is adjusted to approximately 8.5 S.U. (or as set by the operator at the MMI) within the rapid mix tank by feeding sodium hydroxide (pumped by metering pump P-109) to the tank. The rapid mix tank has a retention time of 5 minutes. In this tank, rapid mixing is achieved by a high-speed mixer. This high-speed mixing allows for a rapid pH adjustment, and quick dispersion of added polymer (if polymer is added to the rapid mix tank and not the flocculation tank). Liquid polymer is used to aid in coagulation and flocculation of the metal precipitates and suspended solids and is added to either the rapid mix tank (ME-4) or the flocculation tank (ME-5). The polymer feed system consists of the metering pump (P-25) and Polyblend mixing system (ME-23). Emulsion polymer is fed from a day tank (55-gallon drum) and is diluted to approximately 1 percent by the Polyblend system with potable water before being fed to the rapid mix tank. The flocculation zone has a retention time of 15 minutes. Here, the metal precipitation and suspended solids in colloidal suspension agglomerate onto the polymer and create heavier, solid particles. These solids are then removed in the plate settling zone. The quantity of caustic added for pH

adjustment is regulated by a pH meter (CE-102) in the rapid mix tank. Sludge from the settler/thickener unit is pumped (by sludge pump P-13) to the sludge storage tank (T-5) and dewatered using the filter press (ME-12). The pump P-13 operates off a timer set by the operator at the MMI or by manual operation based on sludge accumulation.

The pH sensor is equipped with automatic washing system that automatically washes the sensor with a potable water stream. The frequency and operating duration of the automatic washing system is controlled by the operator at the MMI or by the local HOA switch (HS-102).

Control Description

The chemical precipitation unit is provided with a local control panel mounted near the unit. This control panel has an HOA switch for the rapid mix tank mixer (ME-17), the flocculator (ME-18), the sludge rake/thickener (ME-19), and the polyblend unit. When the switches are in "Auto" mode, any time process flow is detected by flowmeter FM-803, the mixers and flocculators in the chemical precipitation unit are started and the solenoid valve on the water supply to the polyblend unit (ME-23) is opened. Polymer is pumped from its container into the aging chamber of the polyblend unit by the metering pump (P-25) supplied with the unit. The rate at which the polymer is fed into the polyblend unit is automatically adjusted by the main PLC. For example, as the flowrate through the treatment system increases, the amount of polymer injected into the polyblend unit is increased. However, the amount of water passing through the polyblend unit does not change. Therefore, the polyblend unit sends a more concentrated polymer solution to the rapid mix tank as the treatment system flowrate increases and a less concentrated polymer solution as the system flowrate decreases. The initial polymer solution is adjusted by adjusting the feed pump (P-25) speed and the needle valve on the water supply line. The PLC resets the polymer feed according to the following influent flow as detected by flowmeter FM-803. The 4-20 mA signal from the PLC to the polymer blending unit is based on the 4-20 mA signal from FM/FIT-803 to the PLC. If the influent flow discontinues, the water solenoid valve (SV-23) is closed and metering pump (P-25) is stopped.

In order to facilitate settling of the sediment and oxidized metals in the groundwater, the pH of the process water in the rapid mix tank (ME-4) is raised to approximately 8.5 S.U. or as set by the operator at the MMI. Raising the groundwater pH is accomplished by adding caustic (sodium hydroxide) to the contents of the rapid mix tank. A pH sensor/controller (CE-102) controls caustic addition to ME-4 by transmitting a 4-20 mA signal to the PLC. The PLC activates the caustic metering pump (P-109) when the pH level is below the pH set point. The pumping rate of the metering pump is controlled by the 4-20 mA signal and the PID control loop (controlled by the operator at the MMI). The operator will also input a high pH level and low pH level at the MMI. The PLC will also activate the high pH alarm (CAH-102) if the pH rises above the high pH level and activate the low pH alarm (CAL-102) if the pH drops below the low pH level. These alarms will be activated at the alarm panel and at the MMI. The actual pH level will need to be monitored at the MMI on

a continual basis and the run status of the metering pump will be monitored at the MMI and PLC alarm panel (RUN-P109).

The pH sensor (CE-102) is equipped with an automatic washing system that automatically washes the sensor with a stream of potable water. The frequency and operating duration of the automatic washing system is controlled by the operator at the MMI. The PLC opens and closes solenoid valve SV-102 to control the potable wash water stream. SV-102 can also be controlled by a local HOA switch (HS-102). In “Hand” mode, SV-102 is opened; in “Auto” mode, SV-102 is controlled by the PLC; and in “Off” mode, SV-102 is closed.

Solids that settle out in the lamella clarifier (ME-6) are pumped by sludge pump P-13 to the existing sludge holding tank (T-5) at timed intervals set by the operator at the MMI or by manual operation based on sludge accumulation. The sludge effluent line is equipped with a sample port and piping/valving configuration to allow the operator to pump DNAPL to the existing oil storage tank T-6.

The sludge pump (P-13), which is used to transfer collected sludge to the sludge holding tank (T-5) or to the oil storage tank (T-6), is driven by compressed air from air compressor ME-24. The air supply to the pump is controlled by a solenoid valve that operates based on an adjustable timer in the PLC. The operator controls the timer at the MMI by entering the desired pumping frequency and duration. This timer can be overridden by HOA switches located at the pump and the MCC and upon a high level in sludge holding tank T-5 (LAH-5). The run status of the pump is monitored at the alarm panel (RUN-P13) and the MMI. P-13 can be manually operated by turning either of the HOA switches to “Hand” mode.

2.11 HOLDING TANK (T-2)

Process Description

Effluent from the chemical precipitation unit flows by gravity to a 5,800-gallon, stainless steel holding tank (T-2) for pumping to the activated sludge plant (ME-101) by the VFD pumps P-3, P-4, and P-5.

Control Description

Tank T-2 serves as a pumping tank to the activated sludge plant (ME-101). The tank has a mixer (not used) and a level indicating transmitter (LE/LIT-2). LE/LIT-2 transmits the continuous tank level via a 4-20 mA signal to the PLC. Pumps P-3, P-4, and P-5 are programmed to maintain a target level (LT1-2) in tank T-2. This target level is entered into the MMI by the operator. When the water level is above the target level (LT1-2) the lead pump (P-3, P-4, or P-5) is started. Pump speed is modulated via a variable frequency drive to maintain the target level. If the lead pump (P-3, P-4, or P-5, as set by the operator at the MMI) cannot maintain the target water level, the lag pump is started. When the lag pumps is started, the PLC automatically ramps down the lead pump speed to match lag pump speed, and the pump speeds are ramped up or down together. If both pumps drop below

30 hertz, indicating a reduced flow requirement, then the lag pump is stopped (first on--last off). If the tank level drops below an operator-specified low level (LL1-2) (set by the operator at the MMI), the pump is disabled. The target level (LT1-2) and the low level (LL1-2) are "latched" so that if the water level drops below LL1-2, pumps P-3, P-4, and P-5 will remain disabled until the water level rises to LT1-2. These pumps can also be disabled upon activation of any alarms from process components downstream of T-2. When P-3, P-4, and P-5 are operated in "Hand" mode, they are operated at the speed set by the operator at the MMI. The run status (on/off) of each pump is monitored at the MMI and the PLC alarm panel (RUN-P3, RUN-P4 and RUN-P5) and the speed of each pump is continuously monitored at the MMI and at the MCC. Pumps P-3, P-4 and P-5 are alternated as lead pumps to equalize run time.

If the tank level rises above an operator-specified high level (LH1-2) (set by the operator at the MMI), the field pumps (BWES, PGCS, and ISVE condensate pumps), recycle pumps (P-9 and P-10), and the influent pumps (P-104 and P-105) are disabled and a high level alarm (LAH-2) is engaged at the MMI, the PLC alarm panel, and audibly. This alarm requires operator acknowledgement to disable.

2.12 ACTIVATED SLUDGE TREATMENT PLANT (ME-101)

Process Description

Groundwater is pumped from tank T-2 into one of the aeration zones of the plant for biological treatment via activated sludge contact. The activated sludge plant (ME-101) is a Model R Groundwater Treatment Plant manufactured by Smith & Loveless, Inc.

The activated sludge system has two distinct aeration zones. Lower hydraulic and contaminant loadings will be directed to the smaller aeration zone while higher loadings will be maintained in both the zones. The concentration of activated sludge in the aeration zones is measured as mg/L of MLSS. The activated sludge utilizes the organic matter as food, thereby reducing the BOD₅ and COD in the groundwater. Trace VOCs are also biodegraded and stripped in this system.

Once the groundwater enters ME-101, it is directed to either one or both of the aeration basins within the plant. The groundwater/activated sludge mixture enters the circular clarifier of ME-101 to separate the activated sludge prior to discharge to the sand filter. The separated activated sludge will be returned by airlift to one of the aeration zones. This return activated sludge is directed to the aeration zones to maintain a sufficient concentration of activated sludge (measured as MLSS) in the aeration tanks so that the required degree of treatment can be achieved in a desired time frame. The quantity of sludge returned to the aeration zones can be adjusted to maintain the target MLSS concentration in each zone. Excess activated sludge, known as waste activated sludge (WAS), is airlifted to the aerobic sludge digester for solids mass reduction via digestion. Digested sludge is pumped to the plant's sludge holding/thickening tank (T-5) and decanted prior to either pressing for off-site disposal or pumping (by P-102) to the second sludge

holding/thickening tank (T-104). Air for the aeration system and airlifts is provided by three blowers operating in parallel (ME-102, ME-103, and ME-104). Nutrients (75% nitric acid – HNO_3 or ammonium hydroxide – NH_4OH ; and 75% phosphoric acid – H_3PO_4) is provided to the influent piping to tank T-2 by metering pumps P-110 and P-111. Metering pumps P-110 and P-111 are paced off of flowmeter FM-803. These pumps are used to maintain a desired COD:Nitrogen:Phosphorous ratio of 100:5:1.

The plant has an influent hydraulic capacity ranging from 25,900 gallons per day (gpd) to 86,400 gpd and is capable of treating BOD influent concentrations ranging from 500mg/L to 3,500 mg/L. The target food to microorganism ratio (F/M) for the aeration/activated sludge reactor is 0.5d^{-1} . The Model R unit consists of a 56 foot diameter steel outer tank with a side water depth of 23 feet (total tank depth of 24.5 feet) that contains the following:

- One 37,400-gallon Aeration Zone/activated sludge reactor with coarse bubble diffusers.
- One 261,800-gallon Aeration Zone/activated sludge reactor with coarse bubble diffusers.
- One 43,800-gallon aerobic sludge digester fitted with decant ports capable of providing up to a 9 day hydraulic retention time. The decant ports will allow for flexibility of future plant configuration and operation.
- One 21,900-gallon waste activated sludge holding/thickening zone fitted with decant ports capable of providing a 4.5 day hydraulic retention time.
- One 20-foot, 8-inch diameter steel circular clarifier with waste and return activated sludge airlifts and airlift skimming system, effluent weirs and scum baffles, and effluent discharge.
- Necessary blowers and control system.

Control Description

The activated sludge plant will transmit a high torque condition (NAH-M101) to the PLC if the shear pin in the clarifier's sludge rake/skimmer breaks. If a high torque condition is transmitted to the PLC, then the PLC will engage a high torque alarm (NAH-M101) and disable the field pumps (BWES, PGCS, and ISVE condensate) and upstream process and recycle pump pumps (P-3, P-4, P-5, P-9, P-10, P-104, and P-105). This alarm requires operator acknowledgement to deactivate and return the system to normal operation.

The activated sludge plant also has four internal solenoid valves that control the following: the return activated sludge airlift pump (SV-302), the waste activated sludge airlift pump (SV-301), clarifier scum removal airlift pump (SV-303), and the sludge digester transfer airlift pump (SV-304). Each of these airlifts is controlled by the operator via HOA

operation at the MMI. When a valve is in “Hand” mode, the valve is open and the airlift pump is operating. When a valve is in “Off” mode, the valve is closed. When the valve is in “Auto” mode, the valve will open/close based on the duration and frequency input by the operator into the PLC for that particular solenoid valve.

ME-101 contains a high level switch that will transmit a high water level condition to the PLC. Upon high level, the PLC will activate an alarm (LAH-M101) at the MMI and at the PLC alarm panel, and disable the field pumps (BWES, PGCS, and ISVE condensate) and upstream process and recycle pumps (P-3, P-4, P-5, P-9, P-10, P-104, and P-105). This alarm requires operator acknowledgement to deactivate and return the system to normal operation.

Each of the zones in ME-101 contains a coarse bubble diffusion system with air supplied by blowers ME-102, ME-103, and ME-104 (ME-104 is a back-up). The combined air discharge pipe contains a low air pressure switch (PS-102) that transmits a low/no pressure condition to the PLC. The PLC then activates an alarm (PAL-102) at the MMI, the PLC alarm panel, and audibly and disables the field pumps (BWES, PGCS, and ISVE condensate) and the upstream process and recycle pumps (P-3, P-4, P-5, P-9, P-10, P-104, and P-105). This alarm requires operator acknowledgement to deactivate and return the system to normal operation.

The sludge pump (P-101), which is used to transfer collected sludge to the organic sludge holding tank (T-104) or to the filter press (ME-12), is driven by compressed air from air compressor ME-24. The air supply to the pump is controlled by a solenoid valve that operates based on an adjustable timer in the PLC. The operator controls the timer at the MMI by entering the desired pumping frequency and duration. This timer can be overridden by HOA switches located at the pump and the MCC and upon a high level in tank T-104 (LAH-104). The run status of the pump is monitored at the alarm panel (RUN-P13) and the MMI. P-101 can be manually operated by turning either of the HOA switches to “Hand” mode.

Nutrients (nitrogen and phosphorus) are provided to the biomass by adding ammonium hydroxide to the influent piping of ME-101. The injection point for these chemicals is in tank T-2. The PLC controls the metering pumps (P-110 & P-111) based on flowrate through flowmeter FM/FIT-803 that is transmitted by 4-20mA signals from FM/FIT-803 to the PLC and from the PLC to each metering pump. The run status of each pump is monitored at the MMI and PLC alarm panel (RUN-P110 and RUN-P111).

2.13 TURBIDITY METER (DM-101)

Process Description

Effluent from the activated sludge plant (ME-101) flows through a turbidity meter (DM-101) to monitor the turbidity concentration in the groundwater. If the turbidity concentration is below the level inputted into the MMI by the operator, groundwater flows

by gravity to the sand filter (ME-7). If the turbidity concentration is above the level inputted into the PLC by the operator, the waste stream is routed back to tank T-2 by two three-way solenoid valves (SV-101A and SV-101B).

Control Description

The turbidity meter/transmitter (DM/DIC-101) measures the turbidity level in the activated sludge plant effluent and transmits the turbidity level to the PLC via a 4-20 mA signal. If the turbidity process stream is above the set point for a specified period of time (the high turbidity set point and duration are set by the operator at the MMI), then the PLC activates high turbidity alarm DAH-101 and closes solenoid valve SV-101A and opens SV-101B to direct water through the recirculate line to tank T-2. Upon turbidity dropping below high level point, the PLC deactivates high turbidity alarm DAH-101 and opens SV-101A and closes SV-101B to direct water along main treatment path to sand filter ME-7. DAH-101 is activated at the MMI, the PLC alarm panel, and audibly.

2.14 SAND FILTER (ME-7)

Process Description

The residual suspended solids in the activated sludge system effluent are removed using the existing upflow, continuous backwash sand filter (ME-7). The continuous backwash eliminates the need for a backwash cycle and associated storage facilities and pumps. Groundwater flows by gravity from the circular clarifier of the activated sludge plant to the sand filter. The circular clarifier provides enough gravity head to pass through the sand bed and into holding tank T-3, which follows the filter, without pumping. Continuous backwashing is provided using an airlift pump, which pumps approximately 5 gpm of flow containing the filtered solids to the sand filter backwash pumping tank (T-105). A submersible pump in T-105 pumps the backwash water to the lamella clarifier or allows the backwash water to flow by gravity to tank T-2. Effluent from the sand filter flows by gravity to an existing holding tank (T-3) and is then pumped to either the UV oxidation unit (ME-2) or the sand filter beds (ME-8 and ME-9) and GACs (ME-33 and ME-34), or both by VFD pumps P-6, P-7, and P-8.

Control Description

The sand filter is a complete package with its own local control panel mounted near the unit. The control panel sends a signal to the PLC indicating its run status. The controls included in the local panel are backpressure gauge on the air supply to the airlift pump, a solenoid valve on the air supply line, and a rotameter on the air supply line. The sand filter also has a gauge to measure headloss across the sand bed. The sand filter contains an internal level switch that automatically enables/disables the solenoid valve on the air supply line upon detection of water flow.

2.15 HOLDING TANK (T-3)

Process Description

Effluent from the sand filter flows by gravity to a 3,500-gallon, stainless steel holding tank (T-3) for pumping to the UV/OX unit (ME-2) by the VFD pumps P-6, P-7, and P-8. If the UV/OX unit is bypassed, water from T-3 is pumped directly to the pressure sand filters (ME-8 and ME-9). T-3 is equipped with a pH adjustment system to adjust the pH of its contents to within the system effluent limits, if needed. The pH adjustment system controls chemical addition (sulfuric acid by metering pump P-19 and sodium hydroxide by metering pump P-21) via a proportional integral derivative (PID) control loop.

Control Description

Tank T-3 serves as a pumping tank for the treatment system effluent. The tank has a mixer, used for pH control, and a level indicating transmitter (LE/LIT-3). LE/LIT-3 transmits the continuous tank level via a 4-20 mA signal to the PLC (4 mA = 23.8 inches; 20 mA = 108 inches. These points can be reset by the operator at the MMI). Pumps P-6, P-7, and P-8 are programmed to maintain a target level (LT1-3) in tank T-3. This target level is entered into the MMI by the operator. When the water level is above the target level (LT1-3) the lead pump (P-6, P-7, or P-8) is started. Pump speed is modulated via a variable frequency drive to maintain a tank level set point of 60 inches. If the lead pump (P-6, P-7, or P-8, as set by the operator at the MMI) cannot maintain the set water level (LT1-3), the lag pump is started. When the lag pump is started, the PLC automatically ramps down the lead pump speed to match lag pump speed, and the pump speeds are ramped up or down together. If both pumps drop below 30 hertz, indicating a reduced flow requirement, then the lag pump is stopped (first on--last off). If the tank level drops below an operator-specified low level (LL1-3) (set by the operator at the MMI), the pump is disabled. The target level (LT1-3) and the low level (LL1-3) are "latched" so that if the water level drops below LL1-3, pumps P-6, P-7, and P-8 will remain disabled until the water level rises to LT1-3. These pumps can also be disabled upon activation of any alarms from process components downstream of T-2. When P-6, P-7, and P-8 are operated in "Hand" mode, they are operated at the speed set by the operator at the MMI. The run status (on/off) of each pump is monitored at the MMI and the PLC alarm panel (RUN-P6, RUN-P7 and RUN-P8) and the speed of each pump is continuously monitored at the MMI and at the MCC. Pumps P-6, P-7 and P-8 are alternated as lead pumps to equalize run time.

The pH of the groundwater in T-3 is adjusted to approximately 7 S.U. (or as set by the operator at the MMI), through the addition of sulfuric acid or sodium hydroxide to the contents of tank T-3. A pH sensor/controller (CE-3/CIC-3) controls sulfuric acid or sodium hydroxide addition to T-3 by transmitting a 4-20 mA signal to the PLC (the set points for the 4-20 mA signal and corresponding PID loop are set by the operator at the MMI). The PLC activates the acid metering pump (P-19) when the pH level is above the pH set point. The PLC activates the hydroxide metering pump (P-21) when the pH level is below the pH set point. The operator can also input a high pH level and low pH level at the MMI. The PLC will also activate the high pH alarm (CAH-3) if the pH rises above the high pH level and activate the low pH alarm (CAL-3) if the pH drops below the low pH level.

These alarms are activated at the alarm panel and at the MMI. The actual pH level needs to be monitored at the MMI on a continual basis and the run status of the metering pump is monitored at the MMI and PLC alarm panel (RUN-P18).

If the tank level rises above an operator-specified high level (LH1-2) (set by the operator at the MMI), the field pumps (BWES, PGCS, and ISVE condensate pumps), the influent pumps (P-104 and P-105) and the tank T-2 pumps (P-4, P-5, P-6) are disabled and a high level alarm (LAH-3) is engaged at the MMI, the PLC alarm panel, and audibly. High level alarm LAH-3 requires operator acknowledgement to deactivate and return the system to normal operation.

2.16 ULTRAVIOLET-OXIDATION UNIT (ME-2)

Process Description

The UV-oxidation unit is used if disinfection of the groundwater is needed to reduce the potential of biological growth on the GAC unit. Disinfection occurs from the direct effect of the ultraviolet light. Hydrogen peroxide or other additives are not required in the disinfection process.

Control Description

The UV oxidation unit is a complete package unit from Calgon Carbon Oxidation Systems. The unit has its own local PLC-based control system which interfaces with the overall control system for the treatment plant. The local PLC transmits the operating status to the main PLC. This status is monitored at the MMI and PLC alarm panel. The unit is typically bypassed or operated without any chemical addition, using the lamp alone to destroy residual organics. For safety reasons, the UV-oxidation unit is manually enabled to run at the local control panel only.

2.17 PRESSURE SAND FILTER BEDS (ME-8 & ME-9)

Process Description

Effluent from either the sand filter or UV-oxidation unit is “polished” in sand filter beds units to remove residual contaminants. The sand filter system consists of two units containing 1,500 pounds of sand media each (ME-8 and ME-9). Each unit has a treatment capacity of 30 gpm and is typically run in parallel to achieve the design flowrate of 60 gpm. Effluent from the sand filter beds flows through the 10,000-lb GAC units (ME-33 and ME-24).

Both sand filter beds are equipped with an external automatic backwash system that activates when the pressure differential between the influent pressure sensor (PE/PIT-201) and the effluent pressure (PE/PIT-202) is greater than the operator set difference. The automatic backwash system operates by pumping water from tank T-1 backwards through each filter unit and into tank T-4. Backwash water flow direction is controlled by a

series of automatic valves (SV-201 through 208). Each unit will be backwashed for an operator-defined duration (entered at the MMI). The automatic backwash system can also be set to operate on a operator-defined frequency (entered at the MMI).

Each of the sand filter beds can be packed with 1,500 pounds of granular activated carbon to operate as GAC filters if necessary at a future date.

Control Description

Both sand filter beds are equipped with an external automatic backwash system that activates when the pressure differential between the influent pressure sensor (PE/PIT-201) and the effluent pressure (PE/PIT-202) is greater than the operator-set difference. The pressure from each sensor is transmitted to the PLC by 4-20 mA signals (4 mA = 0 psi; 20 mA = 100 psi). The automatic backwash system operates by using pumps P-1 and P-2 to pump water from tank T-1, pumps P-1 and P-2, backwards through each carbon unit and into tank T-4. The sand filter bed (ME-8) is backwashed first for an operator-defined duration. During backwashing of ME-8, pumps P-6, P-7, and P-8 are disabled; solenoid valves SV-201, SV-202, SV-205, SV-206, and SV-208 are closed; solenoid valves SV-203 and SV-204 are opened; and pumps P-1 and P-2 are enabled. When backwashing of ME-8 is complete, ME-9 is automatically backwashed. During backwashing of ME-9, pumps P-6, P-7, and P-8 are disabled; solenoid valves SV-201, SV-203, SV-204, SV-206, and SV-207 are closed; solenoid valves SV-202 and SV-205 are opened; and pumps P-1 and P-2 are enabled.

Backwash activities continue until the specified duration is complete unless the high level sensor (LSHH-4) is activated or the low level sensor (LSL-1) in tank T-1 is activated.

2.18 GRANULAR ACTIVATED CARBON UNITS (ME-33 & ME-34)

Process Description

Effluent from either the sand filter or UV-oxidation unit is “polished” in the granular activated carbon (GAC) units to remove residual contaminants. The GAC system consists of two units containing 10,000 pounds of carbon each (ME-33 and ME-34). The units have the capability to be operated in series or parallel with any or all units bypassed. Effluent from the GAC units flows through an in-line pH adjustment system prior to discharge.

Control Description

The carbon in the GAC units is replaced as process monitoring indicates. The process monitoring consists of COD analysis by field measurement. The GACs do not require any instrumentation or control. However, each unit has a pressure gauge at both the inlet and effluent pipe to allow the operator to monitor headloss through each vessel. Each vessel is also appropriately piped for a manually activated backwash cycle in the event of a large pressure drop build-up across a GAC bed.

2.19 EFFLUENT PH ADJUSTMENT/METERING SYSTEM

Process Description

The pH of the groundwater exiting the final GAC unit is adjusted to 6 to 9 S.U. (or to a range set by the operator at the MMI) prior to discharge. pH adjustment is accomplished by an in-line pH adjustment system. This system consists of an in-line static mixer (ME-110), an in-line pH sensor (CE-110), and chemical feed pumps (P-20 and P-22). The effluent pH adjustment system may not be operated if the pH adjustment system in T-3 is operated. The pH adjustment system in T-3 is more functional due to longer residence time and better mixing capabilities.

A magnetic-type flowmeter/transmitter (FM/FIT-801) monitors the effluent flowrate (total and instantaneous) and transmit it to the PLC for monitoring at the MMI.

Control Description

The process water is adjusted to a pH of approximately 7.0 S.U. (or as set by the operator at the MMI) prior to discharge to the wetlands. pH adjustment is accomplished by an in-line pH adjustment system. This system consists of an in-line static mixer (ME-110), an in-line pH sensor (CE-110), and chemical feed pumps (P-20 and P-23). The pH sensor controls the pH adjustment by transmitting the pH to the LC via a 4-20 mA signal (4 mA = 0 S.U.; 20 mA = 14 S.U.) The PLC activates the caustic metering pump (P-22) when the pH level is below the pH set point and the sulfuric acid metering pump (P-20) if the pH level rises above the pH set point. The pumping rates of P-20 and P-22 are controlled by 4-20 mA signals from the PLC. The 4-20 mA signals to both P-20 and P-22 are based on the 4-20 mA signal from CE/CIC-110 to the PLC and the PID loop set points at the PLC. The operator can also input a high pH level (typically 9 S.U.) and low pH level (typically 6 S.U.) at the MMI. The PLC also activates the high pH alarm (CAH-110) if the pH rises above the high pH level and activates the low pH alarm (CAL-110) if the pH drops below the low pH level. Also, if the pH goes beyond the desired range, solenoid valve SV-110A closes and SV-110B opens to reroute the process water to tank T-2. When the pH is back within the desired range, SV-110A opens and SV-110B closes to allow the process water to discharge to the wetland. These alarms are activated at the alarm panel and at the MMI. The actual pH level is monitored at the MMI on a continual basis and the run status of each of the metering pumps is monitored at the MMI and PLC alarm panel (RUN-P20, and RUN-P22).

A magnetic-type flowmeter/transmitter (FM/FIT-801) monitors the effluent flowrate (total and instantaneous) and transmits it to the PLC for monitoring at the MMI. The discharge pH is continuously monitored by an in-line effluent pH sensor and transmitted to the PLC via a 4-20 mA signal.

2.20 INORGANIC SLUDGE HANDLING SYSTEM

Process Description

The inorganic sludge handling system provides a means to accumulate and concentrate metals sludge from the lamella clarifier and pretreatment system sludge prior to dewatering for off-site disposal.

Solids that settle out in the gravity phase separation tank (T-101), CPI oil/water separator (ME-1), and lamella clarifier (ME-6) are pumped on an intermittent basis to the sludge holding tank (T-5). Sludge is allowed to settle and thicken in this tank prior to dewatering. T-5 is equipped with multiple decant ports to discharge free water to the filtrate/decant holding tank (T-4). The decant line is equipped with a sight glass so that the operator can assess the quality of the liquid being decanted from the tank. Decant water from T-4 is then pumped back to either the influent of the gravity phase separation tank (T-101) by pump P-10 or the aeration/equalization tank (T-102) by pump P-9. Thickened sludge from the storage tank (T-5) is pumped by pump P-14 to a filter press (ME-12) for dewatering. ME-12 has a 30 cubic foot capacity. Metering pump (P-32) adds a precoat to the filters prior to sludge dewatering to prevent sludge from sticking to the filters. Filter cake from the press drops into the roll-off dumpster and is periodically transported off-site for disposal. Operation of pump P-14, pump P-32, and the filter press (ME-12) are controlled by the local control panel of the filter press. The operation of this equipment can be monitored by the main PLC.

2.20.1 Control Description for Tank T-5

Solids that settle out in the gravity phase separation tank (T-101), CPI oil/water separator (ME-1), and lamella clarifier (ME-6) are pumped on an intermittent basis to the existing sludge holding tank (T-5). T-5 is equipped with a mixer, high level switch, low level switch, and sludge pump (P-14) to transfer sludge to the filter press. The tank also has four decant ports that are manually operated.

The operation of sludge pump (P-14) is controlled by the filter press local control panel (See Section 2.20.3). The operating status of P-14 (RUN-P14) can be monitored at the MMI and PLC alarm panel. When the tank sludge level reaches the high level switch LSH-5, and alarm condition is transmitted to the PLC and sludge pumps P-12, P-13, and P-101 disabled. A high level alarm (LAH-3) is then engaged by the PLC at the MMI, the PLC alarm panel, and audibly. When the tank sludge low level drops below low level switch LSL-5, a signal is transmitted to the PLC for monitoring at the MMI.

2.20.2 Control Description for Tank T-4

This tank receives decant water from tank T-5, water from the floor sumps, backwash from the sand filters, and filtrate from the filter press. Pump P-9 is used to pump water from T-4 to the influent of T-102 and Pump P-10 is used to pump water from T-4 to the influent of T-101. The operator manually selects the pumps and water destination by manually adjusting valves on the effluent of each pump. When the tank level rises above LSH-4, either pump P-9 or pump P-10 (depending on the valve setting) is started and operated until

the tank level drops below LSL-4. The operating status of both pumps can be monitored at the MMI, PLC alarm panel, and MCC. If the tank level rises above LSHH-4, high level alarm (LAH-4) is activated at the MMI, the PLC alarm panel, and audibly, and also the PGCS, BWES, and ISVE pumps and process pumps P-1, P-2, P-3, P-4, P-5, P-104, and P-105 are disabled. This alarm requires operator acknowledgement to deactivate alarm and return system to normal operation.

2.20.3 Control Description for the Filter Press (ME-12)

The entire operation of the filter press is controlled by a local control panel located at the unit. The panel controls the sequence of the dewatering process, and the support systems which include sludge pump P-14, the precoat feed system, and air supply to the press. The local control panel sends a signal to the main PLC indicating run status (RUN-M12) at the MMI and PLC alarm panel.

2.21 BIOLOGICAL SLUDGE HANDLING SYSTEM

Process Description

Waste activated sludge is pumped from the aerobic sludge digester of the activated sludge plant for mass removal by digestion. An air diffusion system supplies oxygen necessary to achieve sludge digestion in the aerobic digester. Approximately 30% of the Volatile Suspended Solids (VSS) are digested in the aerobic digester. Following digestion, the digested sludge is transferred to the sludge holding/thickening zone of the activated sludge treatment plant. The digested sludge is allowed to settle and thicken for up to 5 days prior to dewatering. Thickened sludge from the activated sludge plant holding/thickening tank is either pumped to the filter press (ME-12) or to a second sludge holding/thickening tank (T-104). Sludge within tank T-104 is allowed to settle and thicken prior to dewatering. T-104 is equipped with multiple decant ports to discharge free water to the existing backwash/decant holding tank (T-4) (See Section 2.20.2 for information regarding T-4). The decant line is equipped with a sight glass so that the operator can assess the quality of the liquid being decanted from the tank. Thickened sludge from the storage tank (T-104) is pumped by pump P-14 for dewatering to a filterpress (ME-12). The filter press operates as discussed in Section 2.20.

2.21.1 Control Description for Tank T-104

Digested sludge is pumped by sludge pump P-102 on an intermittent basis to the biological sludge holding tank (T-104). T-104 is equipped with a high level switch. The tank also has four decant ports that are manually operated.

When the tank sludge level reaches the high level switch LSH-104, an alarm condition is transmitted to the PLC and sludge pump P-102 disabled. A high level alarm (LAH-104) is then engaged by the PLC at the MMI, the PLC alarm panel, and audibly. This alarm condition requires operator acknowledgement to deactivate alarm and re-enable pump P-102.

2.22 HOLDING TANK (T-1)

Tank T-1 receives water from the GWTP effluent for backwashing the sand filter beds (ME-8 and ME-9) and is equipped with two effluent pumps, three level switches, and a mixer (not used). When the tank level is below LSH-1, tank T-1 is in “fill mode” to fill it with water for backwashing ME-8 and ME-9. In “fill mode” solenoid valves SV-110A, SV-110B, SV-201 and SV-207 are closed, solenoid valves SV-202, SV-203, SV-204, SV-205, SV-206, and SV-208 are opened and pumps P-1 and P-2 are disabled. When water reaches the high level switch, SV-110A is opened and SV-208 is closed and the system operates as normal (i.e., the effluent is discharged to the wetlands). During automatic backwashing activities for ME-8 and ME-9, the lead pump (either P-1 or P-2) is started by the PLC. Pump P-1 or pump P-2 pumps until the backwash operation is complete or until the water level in T-1 drops below the low level switch (LSL-1). Pumps P-1 and P-2 are automatically alternated by the PLC on successive starts. HOA switches for each pump are provided near the pumps.

2.23 CATALYTIC OXIDIZER/SCRUBBER (ME-106)

Process Description

Approximately 95% stripping efficiencies is achieved for the VOCs in the aerated equalization tank; therefore, off-gases from the aerated equalization tank are routed through a demister to a catalytic oxidation unit. Ninety-five percent destruction efficiencies are expected for each of the individual VOCs. Volatile organic compounds are thermally decomposed into carbon dioxide (CO₂), water vapor, and chlorine. The off-gases from the catalytic oxidizer are vented to a scrubber which reduces chlorine emissions. A recuperative heat exchanger is used to lower the use of natural gas by preheating the off-gases before they enter the catalytic oxidizer.

The CAT-OX unit can be operated in “bypass” or independent mode by turning on the “bypass” mode on the PLC/MMI. This is not a true bypass mode; rather it allows the unit to continue running even when the rest of the system shuts off. Normally, when the system goes down, the CAT-OX unit turns off also. The rest of the system can be restarted remotely, but the CAT-OX unit cannot. The advantage of the “bypass” mode is that if the CAT-OX unit continues to run, the system can be restarted remotely and CAT-OX unit will continue to operate.

Control Description

The catalytic oxidizer and scrubber units (collectively referred to as the CAT-OX unit) are two separate units designed to function as one system. Each unit has its own local control panels (LCP-106A and LCP-106B); however, the local control panel on the scrubber (LCP-106B) is the primary control panel that controls the oxidization/scrubber process and interfaces with the GWTP's PLC. LCP-106B controls the startup logic, the process monitoring, interlocks, and the emergency stop for both the oxidizer and scrubber.

LCP-106B receives the shutdown signal from the GWTP PLC to disable the CAT-OX upon failure or shutdown of blower ME-105, and LCP-106B transmits a shutdown signal to blower ME-105 upon shutdown of the CAT-OX unit or closure of the air inlet valve. A chart recorder is also in the oxidizer control panel that records process flowrate (in SCFM), catalyst inlet temperature and catalyst exit temperature. The control panel on the oxidizer (LCP-106A) is used to monitor the oxidizer process alarms and parameters, control the process components, and transmit the operation status to LCP-106B and the GWTP PLC.

2.24 CAUSTIC STORAGE TANK (T-8)

Process Description

Caustic soda (sodium hydroxide – NaOH) is stored in the caustic storage tank (T-8) for supply to the caustic metering pumps. T-8 contains a low level switch (LSL-8) that activates an alarm to notify the operator that the tank needs to be refilled.

Control Description

When the caustic level drops below level switch (LSL-8), the PLC activates an alarm (LAL-8) at the MMI, PLC alarm panel, and audibly to notify the operator that the tank needs to be refilled.

2.25 SULFURIC ACID STORAGE TANK (T-9)

Process Description

Sulfuric acid (H_2SO_4) is stored in the acid storage tank (T-9) for supply to the sulfuric acid metering pumps. T-9 contains a low level switch (LSL-9) that activates an alarm to notify the operator that the tank needs to be refilled.

Control Description

When the sulfuric acid level drops below level switch (LSL-9), the PLC activates an alarm (LAL-9) at the MMI, PLC alarm panel, and audibly to notify the operator that the tank needs to be refilled.

2.26 STORAGE TANK (T-7)

Process Description

Tank T-7 is a stainless steel storage tank that may be used to store scrubber blowdown water, peroxide for the UV-OX Unit, or other liquid material requiring temporary storage. The interior of T-7 should be properly cleaned prior to changing the nature of its contents. Tank T-7 is equipped with a low level switch (LSL-7) that activates an alarm (LAL-7) to notify the operator when the tank is low and requires refilling.

Control Description

When the contents of the tank fall below the low level switch (LSL-7), the PLC activates an alarm (LAL-7) at the MMI, PLC alarm panel, and audibly to notify the operator that the tank needs to be refilled.

2.27 IN-GROUND SUMPS

Process Description

There are main floor sumps (North, Middle, and South) and one floor sump in the filter press room. Submersible pumps in each sump pump collected water to the influent of tank T-4. The pumps pump water based on an internal ball-type float switch. Each sump is also equipped with a high level switch that activates an alarm if the sump fills up.

There is also a sump located by the aerated equalization tank (T-102) for the outside secondary containment system. This sump contains a submersible pump with internal float switch to pump water collected in the outside secondary containment system to the effluent piping of T-102 for treatment.

Control Description

Each sump pump has an internal float switch that enables/disables the pump. The North, Middle, and South sumps are also equipped with high level switches (LSH-10A, LSH-10B, and LSH-10C) that transmit a high sump level if the pumps cannot sufficiently pump down the sumps. These alarms (LAH-10A, LAH-10B, LAH-10C) are activated by the PLC at the MMI, PLC alarm panel, and audibly and require operator acknowledgement to deactivate and return the system to normal operation.

2.28 AIR COMPRESSOR (ME-24)

Process Description

Air compressor ME-24 is a dual 15-horse power motor air compressor capable of 100 SCFM or compressed air at 175 psi. This air compressor and associated air dryer are used to provide compressed air for equipment located in the treatment system building including the filter press, sand filter, sludge pumps, and carbon backwashing activities.

Control Description

The air compressor contains a pressure element (PE/PIT-24) that activates an alarm if the air supply drops below an adjustable set point. The alarms are activated at the MMI, the PLC alarm panel (PAL-24), and audibly.

2.29 PROGRAMMABLE LOGIC CENTER, MAN-MACHINE INTERFACE, AND MOTOR CONTROL CENTER

The Main or Master Control Panel consists of a Nema 12 enclosure housing, an Allen-Bradley SLC-503 PLC system, and a personal computer (PC) (MMI) running INTELLUTION software. The MMI, PLC, and a 24 VDC power supply are protected by a Best UPS. All I/O can be assigned to continuous trend logs so the entire plant can be viewed over time at the MMI via the computer monitor and/or printer. The full MMI capability can be remotely accessed by using INTELLUTION software. The MMI (computer) monitor will schematically depict the plant flow diagram with realtime variables superimposed. The system ladder logic and output/data files are located in Volume 11 of this O&M Plan.

2.29.1 Programmable Logic Controller (PLC)

Signals from the plant instruments (flowmeters, pH transmitters, turbidity meter, level controllers, etc.) are transmitted to the PLC. The PLC displays the readings to the operator via the MMI. The PLC controls the process equipment by using predetermined set points and conditions and operator adjustable set points and conditions (inputted to the MMI by the operator) and transmitting the signal to the equipment (pumps, solenoid valves, blowers, chemical metering pumps, mixers, etc.) An alarm panel is located on the PLC panel door. This alarm panel contains alarm and run lights of most of the equipment in the treatment system.

An emergency stop button is located on the PLC panel door and is used to stop the entire plant operation. An alarm horn is also located on the PLC panel door and is used to audibly annunciate all user selectable alarms.

2.29.2 Man-Machine Interface (MMI)

The MMI is a personal computer that the operator uses to monitor the general operating status of the treatment system and of the individual process equipment, control the flowrate through the treatment system, and input operating set points and conditions.

2.29.3 Motor Control Center (MCC)

The motor control center (MCC) distributes electrical power to the process components and lighting panels. The MCC contains the circuit breakers, disconnect switches, starter, and variable frequency drive for the larger process equipment. Equipment control can be manually operated by HOA switches located on the MCC. The MCC is used by the PLC to enable/disable equipment.

2.29.4 Proportional, Integral, Derivative (PID) Control Loops

Chemical pumping rates for the pH adjustment systems are controlled at the MMI by proportional, integral, and derivative (PID) control loops by 5/04-type controllers. Detailed information pertaining to PID control loop tuning and description is included as Attachment A to this manual. A summary of the primary variables is presented below.

- **Setpoint.** This variable is the target pH setpoint for the particular pH adjustment system. The units of this variable are in standard pH units (S.U.).
- **Gain.** Universally known as proportional gain, the gain factor increases or decreases the output of the metering pump based on the difference in the actual pH to the target pH (the greater the pH difference, the faster the metering pump pumps; the smaller the pH difference, the slower the metering pump pumps). The range proportional gain is from 0 to 327.67.
- **Reset.** Universally known as integral gain, the reset factor increases or decreases the output of the metering pump based on the how long that the difference has existed (if the actual pH has not attained the target for a long time, the pumping rate of the metering pump will increase; if the actual pH has only recently varied from the target pH, then the metering pump pumping rate will be slow). The range for reset is from 0 to 327.67.
- **Rate.** Universally known as derivative gain, the rate factor increases or decreases the output of the metering pump based on the rate of change of the actual pH (if the actual pH is changing slowly, the pumping rate of the metering pump will increase; if the actual pH is changing quickly, then the metering pump pumping rate will slow down). The range for rate is from 0 to 327.67.

See Attachment A for information regarding tuning the PID control loops and setting the gain, reset, and rate.

3.0 EQUIPMENT INDEX

A list of primary equipment is contained in Table 3-1. This table contains the equipment identification designation, the equipment name, capacities, manufacturer, model, and vendor contact names and numbers, and the volume of this O&M Manual within which specifications provided with the equipment are located.

4.0 INITIAL SET POINTS AND STARTUP PROCEDURES

4.1 INITIAL SET POINTS

Initial set points for the control equipment and initial chemical addition rates are contained on Table 4-1.

4.2 INITIAL EQUIPMENT TESTS

If any new equipment is added in the future to the treatment process, the new equipment will need to be tested prior to startup of that component and all of the existing equipment will need to be tested prior to/or during integration of the new equipment to ensure that they will meet the new process requirements. Initial testing of the individual components is important because the existing GWTP cannot be shutdown for any significant time making a complete system startup test impossible.

4.2.1 Initial Functional Tests

All new tanks, vessels, and piping should be leak tested with potable water. During this test, individual tanks and pipes should be filled with potable water or clean site water and all connections, fittings, and valves should be observed for leaks. Following leak testing, repairs should be made as necessary and the equipment and piping should be retested to ensure the leaks have been properly repaired. The utility supply lines should also be tested.

After the treatment system has been checked for leaks and any repairs made, a functional test should be conducted on each process unit. Functional tests on new equipment should be conducted using potable water if possible. Existing equipment will need to be tested with process water due to the inability to shutdown the GWTP for extended periods of time. All new and existing controls, alarms, valves, pumps, and motors should be verified for proper function. The functional test requirements for the major components of the extraction and treatment systems are listed in Table 4-2. The purpose of the functional tests on the new equipment is to ensure that the equipment and all of its components were installed and operate properly. The purpose of the functional tests on the existing is to ensure that the equipment and their components are working properly. This is important because existing process components may serve a different role with the addition of new process components.

4.3 STARTUP OF NEW EQUIPMENT

An important part of the startup of the new equipment and integration of this equipment into the GWTP is process monitoring. Process monitoring consists of sample collection for laboratory and/or field analysis. It also consists of monitoring and documenting groundwater levels, flowrates, pH levels, chemical addition rates, sludge generation rates,

and process interruptions or changes. Several of these requirements are outlined in Section 6. During startup of the new components, initial samples will be collected to establish a baseline for optimizing the system. The requirements for the initial baseline are also outlined in Section 6. Startup procedures for each component added during the GWTP upgrade process of 2000 are summarized below.

4.3.1 Gravity Phase Separator (T-101)

- Confirm that plant air supply is available at the sludge pump (P-101) and that the air pressure and pump cycle time are adjusted to the desired values.
- Verify that the BWES extraction pumps are set for normal operations.
- Direct the desired BWES influent lines to T-101 to begin pumping of groundwater to the treatment facility.
- Inspect the tank for leaks in the piping connection and fittings.
- Verify the high level alarm (LAH-101) is not activated when the tank is filled to its operating level.
- Confirm operation of the air solenoid valve for sludge pump P-101.
- Verify that check valves in the P-101 effluent seat completely.
- Open the influent valve to the sludge pump.
- Open the effluent valve from the sludge pump.

4.3.2 Mixing Tank (T-103)

- Close the tank drain valve(s).
- Calibrate the pH monitoring system and enter the setpoints and PID control parameters on the PLC.
- Open the influent and effluent valves.
- Verify that the chemical feed system is operational and is set to "Auto" mode.
- When the tank is approximately one-half full, turn on the mixer (ME-109).
- Verify the pH control on the PLC.

4.3.3 Aerated Equalization Tank (T-102)

- Verify that the diffusers are level. Level diffusers if necessary.
- When the water level reaches approximately one-foot above the diffusers, turn on the catalytic oxidizer/scrubber unit (ME-106). ME-106 will automatically start the blower (ME-102).
- Verify that the bubbles from the diffusers are distributed equally. If there is uneven distribution of bubbles, shut off the influent water and adjust the diffuser nozzles.
- As the tank is filling, verify that the level probe indicates the correct fluid level.
- Inspect the tank for leaks in the piping connection and fittings.
- Check effluent pump (P-104 and P-105) lubrication, alignment, and rotation.
- Check the sample port to ensure that the sample valve is closed.
- Open all valves in the pump suction lines and pump discharge lines.
- Set the HOA switch for pumps to “Auto” at the MCC.
- Verify that pump operation corresponds to the level or flow setting.
- Verify automatic shutoff at low-level in the aerated equalization tank (T-102) and automatic start at high level in the tank.
- Check for unusual noise, vibrations, overheating, and leakage.
- Verify operation of the defoamer addition system (P-108).

4.3.4 Activated Sludge Plant (ME-101)

- Follow the manufacturer’s startup procedure as detailed in the manufacturer’s operation and maintenance manual by Smith & Loveless manual located in Volume 10 of this manual. Conduct process monitoring in accordance with Section 6 of this manual.
- Check for leaks in the tank, piping, and fittings.
- Perform process monitoring as specified.
- Verify operation of high level switch (LSH-M101).
- Check operation of the nutrient addition systems. Collect field a COD sample to set the flowrate of these pumps to maintain a COD:Nitrogen:Phosphorous ratio of

100:5:1. Note that the injection point for the nutrient addition systems is in the influent pipeline to the activated sludge plant.

- Verify operation of the blowers, air diffusion system, and air lifts.
- Verify operation of the sludge rake in the clarifier.
- Confirm that plant air supply is available at the sludge pump (P-102) and that the air pressure and pump cycle time are adjusted to the desired values.
- Observe clarifier effluent to ensure large amounts of solids are not escaping.
- Ensure clarifier effluent weir is level.
- Conduct the following analytical analysis on any sludge that is added to the GWTP: TSS, VSS, inorganics/metals, SVOCs, VOCs, and pesticides/PCBs. This analysis will help in startup and in acclimating the biomass. This analysis will help to ensure that the sludge will not contain any contaminants that will negatively effect the operations of the activated sludge plant and entire GWTP.

4.3.5 Effluent pH Adjustment/Monitoring System

- Verify that the chemical feed system is operational and is set to “Auto” mode.
- Verify power to the magnetic flow meter (FE/FIT-801).
- Verify operation of solenoid valve (SV-110).
- Verify the pH control on the PLC, including the set points (alarm points, target set point, PID control parameters, and 4-20 mA signal set points from the pH controller to the PLC) are correct.
- Verify flow rate on the PLC.

4.3.6 Catalytic Oxidizer/Scrubber (ME-106)

- Follow the manufacturer’s startup procedure as detailed in the manufacturer’s operation and maintenance manual prepared by Catalytic Combustion, located in Volume 10 of this manual.
- Verify the blower ME-102 engages when ME-106 is operated in “Auto” or “Hand” mode.
- Verify that that there is sufficient paper in the chart recorder.
- Verify the shutdown control at the PLC.

- Verify that the air flowrate, inlet air temperature and outlet air temperature is being transmitted to the PLC.
- Verify that the natural gas, caustic solution, and potable influent valves are open and that ME-106 is receiving all three.
- Verify the blowdown effluent valve is open and that blowdown is discharging to T-7 and that the blowdown water does not drain back into the scrubber from tank T-101 or other designated location.

4.3.7 Chemical Feed Systems

This section covers startup of new chemical metering pumps. However, in the event that new process components are later added to the system, the entire chemical feed system should be checked and started in this manner because existing metering pumps may be used in a different capacity during operation of the GWTP after the addition of new components. This method ensures integrity of the feed system as a complete unit and also allows for timely startup of the down-stream treatment processes that depend on the chemical feed system for an effective treatment.

- Verify that the metering pumps are capable of the required pumping rates.
- Verify that stock solutions are available in tanks (T-8, T-9, drums and totes).
- Verify that foot valves and the 4-function valves for the chemical pumps are in correct position.
- Open valves in the suction lines of the metering pumps.
- Open valves in the discharge lines of the metering pumps.
- Verify individual metering pumps for are primed.
- Verify that the individual metering pumps will discharge to the intended unit.
- Set electrical connections to “Hand” at the pump local control panel.
- Set stroke length and frequency for each pump.
- Check for unusual noise, vibrations, overheating, and leakage.
- Set electrical connections to “Auto” and verify proper PLC control operation.

4.3.8 Organic Sludge Holding Tank (T-104)

- Close the tank outlet valve and the sample port.
- Close all valves on the tank decant discharge lines except when decanting liquid above the settled sludge.
- Check for leaks in the tank, piping, and fittings.
- Verify that adequate sludge is available in the T-104 to fill the filter press with a full load of sludge. Open sludge outlet valve. Note that sludge pump P-14 is used to pump sludge to the filter press from both T-104 and T-5. The operation of the influent pipes to this pump is manual.
- Follow manufacturer's instructions for actual startup of the filter press (ME-12).
- Verify that Sludge pump P-14 is controlled by and interlocked with the filter press PLC.

4.4 NORMAL OPERATION/SHUTDOWN OF THE GROUNDWATER TREATMENT PLANT

4.4.1 Perimeter Groundwater Containment System Extraction System

The PGCS groundwater extraction and conveyance systems are designed to operate continuously, automatically, and unattended except for normal maintenance. Procedures for the system operation are outlined below. Volume 5 (Instrumentation and Control Equipment Manual) contains a description of the instrumentation and control system components and manufacturer's literature.

Normal Operation of the PGCS

- Check and clean internal components of the flow meters quarterly to remove any solids that may have accumulated.
- Verify pump operation daily by observing flow rate at the flowmeter (FM-802) in the influent manifold.
- Periodically adjust the pump flowrate to the desired level at the influent manifold by adjusting the appropriate valves on the pump discharge pipe.
- Periodically check flow meters (FM-802) and the flow totalizer on the PLC.
- Check and clean the extraction pumps to remove any scale and solids that may have accumulated when the flow decreases substantially or the current draw increase.

The pumps and the extraction systems are to be periodically checked for water quantity, pressure, drawdown, periods of cycling, and operations of control. The extraction pumps may cycle on and off if the following conditions occur:

- If the water level in any extraction trench drops below the low-level switch setting on the pump, the extraction pump will shut off. If the water level rises to the high-level switch setting in a well operating in “Auto” mode, the extraction pump will restart.
- If the water level in any of the treatment tanks rises above an alarm level, all of the extraction well pumps will shut off. The PGCS pumps require operator acknowledgement of the alarm to be re-engage.

Shutdown of the PGCS

- Turn the HOA switch for desired pump to “Off.”
- Turn “Off” the power supply.
- After the pump is stopped, close the valve on the pump discharge pipe.
- Once water in the manifold pipe has drained to influent equalization tank (T-102), close the tank influent valve.
- Turn off flow meter (FM-802) to prevent damage if water drains from the header piping to the pump sump.
- For an extended shut down, disconnect discharge piping to the pump, remove and clean the pump, and store in a dry, clean place per the manufacturer’s recommendation.

4.4.2 Barrier Wall Extraction System

The BWES groundwater extraction and conveyance systems are designed to operate continuously, automatically, and unattended except for normal maintenance. Procedures for the system operation are outlined below. Volume 5 (Instrumentation and Control Equipment Manual) contains a description of the instrumentation and control system components and manufacturer’s literature.

Operating instructions for the BWES control panels located at individual extraction wells will be included in the Addenda to be added to this O&M manual at the completion of the Off-Site Area ISVE system.

Normal Operation of the BWES

- Check and clean internal components of the BWES flowmeter(s) quarterly to remove any solids that may have accumulated.

- Verify pump operation daily by observing flow rate at the flowmeter(s) in the BWES influent piping.
- Periodically adjust the pump flowrate to the desired level at the influent piping by adjusting the appropriate valves on the pump discharge pipe.
- Periodically check the flow meters and the flow totalizer on the PLC. If a flowmeter becomes blocked by sediment, clean the meter in accordance with the manufacturer's O&M manual (Vol. 9 of this manual). If this is a repetitive problem, install a filter screen on the influent line to the flowmeter.
- Check and clean the extraction pumps to remove scale and solids that may have accumulated when the flow decreases substantially or the current draw increases.
- Record run time hours regularly from the hour meters mounted on each extraction well.

The pumps and the extraction systems are to be periodically checked for water quantity, pressure, drawdown, periods of cycling, and operations of control. The extraction pumps may cycle on and off if the following conditions occur:

- If the water level in any extraction trench drops below the inlet of the pump, the extraction pump will be shut off by the pumps local "motor minder". After a preset time delay the extraction pump will restart if the water level has risen to the level of the pump inlet.
- If the water level in one or more of the GWTP treatment tanks rises above an alarm level, all of the extraction well pumps will shut off. If the water level then drops below the low-level setting, the extraction well pumps will restart upon operator acknowledgement of the alarm.

Shutdown of the BWES

- After the pump is stopped, close the valve on the pump discharge pipe.
- Once water in the manifold pipe has drained to the destination tank (either T-101 or T-102), close the tank influent valve.
- Turn off the flow meter to prevent damage if water drains from the influent piping to the pump sump.
- For an extended shut down, disconnect discharge piping to the pump, remove and clean the pump, and store in a dry, clean place per the manufacturer's recommendation.

4.4.3 Gravity Phase Separator (T-101)

Normal Operation of T-101

- Check for leaks in the tank, piping, and fittings.
- Periodically check the oil-water interface depth in the separator.
- Adjust position of decant valves as necessary to decant oil/LNAPL from the top of the process water.
- Periodically check the sludge depth inside the phase separator. It is recommended that the sludge removal pump P-101 be operated on a timed basis. However, the pump can be operated manually if needed. Adjust the sludge pump cycle frequency and pumping rate as necessary.
- On a quarterly basis, drain the tank and manually flush out solid deposits from the bottom of the phase separator.

Shutdown of T-101

- If the entire system is to be shutdown, ensure that the extraction pumps and recycle pumps P-9 and P-10 are shutdown and that water is no longer flowing into T-101, then close the T-101 influent valves. If the entire system is not going to be shutdown, open the valves on the T-101 bypass line and close the T-101 influent and effluent valves.
- Dewater contents of the tank with sludge pump P-101 and close the pump outlet valve.

4.4.4 Mixing Tank (T-103)

Normal Operation of T-103

- Check the tank and piping for leaks.
- Verify that chemical solutions are available. When needed, order fresh stock.
- Verify that the chemical feed pumps are in “Auto” position.
- Periodically check the pH sensor and chemical feed ports to ensure that the sensor and the chemical feed lines are secure.
- Check mixer for lubrication, noise, vibration, alignment, and shaft motion.
- Verify operation and calibration of pH sensor on a periodic basis.
- Verify pH control on the PLC.
- Verify operation of the pH sensor’s automatic washing system.

Shutdown of T-103

- If the entire system is to be shutdown, ensure that the extraction pumps and recycle pumps P-9 and P-10 are shutdown and that water is no longer flowing into T-103, then close the T-103 influent valves. If the entire system is not going to be shutdown, open the valves on the T-103 bypass line and close the T-103 influent and effluent valves.
- Shut off the chemical feed system and turn mixer control switch to the "Off" position.
- Manually close the solenoid valve (SV-103) for the pH sensors automatic washing system.
- Adjust the pH of the water to 7 before shutdown. Remove and clean the pH sensor and store in clean storage solution if the shut down is for more than a few days or anytime the sensor will not be submerged.
- Drain or pump the tank to the sump.

4.4.5 Corrugated Plate Interceptor Oil/Water Separator (ME-1)

Normal Operation of ME-1

- Periodically check the effluent weir depth and adjust as necessary.
- Periodically check the oil-water interface depth in the separator. Adjust the plate pack height accordingly.
- Periodically check the sludge depth inside the phase separator. It is recommended that the sludge removal pump P-12 be operated manually. However, a preset pump run timer is available on the MMI screen and can be used to set the time interval of operation once frequency of pumping has been established.
- On a quarterly basis, drain the tank and manually flush out solid deposits from the plate pack and at the bottom of the phase separator.
- Conduct equipment inspection, process control, and routine maintenance per the equipment manufacturer's recommendations.
- Complete the operator checklist and record all data required on the operation logs.

Shutdown of ME-1

- If the entire system is to be shutdown, ensure that the extraction pumps are shutdown and that water is no longer flowing into ME-1, then close the ME-1 influent valves. If the entire system is not going to be shutdown, open the valves on the ME-1 bypass line and close the ME-1 influent valves.

- If the entire system is to be shutdown, remove NAPL and sludge from storage tanks by manually activating the sludge pump (P-12).
- Flush the system with clean water as it may contain water with a pH of 4.
- Manually flush out solids from the plate pack and drain the separator completely.
- Close ME-1 effluent valves.

4.4.6 Aerated Equalization Tank and Pumps (T-102, P-104, P-105)

Normal Operation of T-102

- Check for leaks in the tank, piping, and fittings.
- Verify operation of level controller.
- Check operation of the defoamer addition system (P-108). Note that the injection point for P-108 is in the influent piping to T-102.
- Check for the presence of turbulence by the air diffusion system. If a decrease in turbulence is noticed, shutdown T-102 and clean diffusers and piping and investigate blower ME-102.
- Check pumps for solids build up.
- Check pumps for lubrication, alignment, and rotation.
- Check pumps for unusual noise, vibrations, overheating, and leakage.
- Check pump motors for operating temperature and shaft motion.
- Check the pressures on the pump effluent. If pressure is high, shutdown pumps and clean check valves and piping.
- Check demister for blockage.

Shutdown of T-102

- If the entire system is to be shutdown, ensure that the extraction pumps and recycle pumps P-9 and P-10 are shutdown and that water is no longer flowing into T-102, then close the T-102 influent valves. If the entire system is not going to be shutdown, open the valves on the T-102 bypass line and close the T-102 influent valves.
- Shutdown the catalytic oxidizer scrubber unit (ME-106) and ensure that the blower is shut off.

- Dewater contents of the tank with pumps P-104 and P-105.
- Shut off the pumps by turning the respective control switch at the MCC to “Off” or by selecting “Off” in the computer control system when the control switch on the MCC is in the “Auto” position.
- Check the motor for shaft motion.
- Close all valves on the pump influent and effluent lines.

BE CAREFUL WHEN SHUTTING DOWN T-102 IN WINTER DUE TO THE POTENTIAL FOR FREEZING.

4.4.7 Chemical Precipitation Unit (ME-4, ME-5, ME-6)

Normal Operation of the Lamella Clarifier (ME-6)

- Refer to manufacturer’s literature for regular operations and maintenance.
- Inspect the overall system for leaks and general integrity.
- Verify that the unit is operating in “Auto” mode at the PLC/MMI.
- Verify operation of all pumps, mixers and pH sensors.
- Verify that chemical solutions are available. When needed, order fresh stock.
- Periodically check the pH sensor and chemical feed ports to ensure that the sensor and the chemical feed lines are secure.
- Perform process monitoring as specified.
- Adjust the sludge pump cycle frequency and pumping rate as necessary.
- Verify operation of the pH sensor’s automatic washing system.

Shutdown of the Lamella Clarifier (ME-6)

- If the entire system is to be shutdown, ensure that the extraction pumps and recycle pumps P-9 and P-10 are shutdown and that water is no longer flowing into the Flash Mix/Floc Tank ME-4, then close the ME-4 influent valves. If the entire system is not going to be shutdown, open the valves on the ME-4 bypass line and close the ME-4 influent valves.
- Shut off the pump in the sand filter backwash water holding tank (T-105).
- Shut off the chemical feed system and turn the control switches for the mixers to the “Off” position.

- Manually close the solenoid valve (SV-102) for the pH sensors automatic washing system.
- Clean and flush the system with fresh water.
- Remove and clean the pH sensor and store in clean storage solution if the shut down is for more than a few days or when the pH sensor is not submerged.
- Check the sludge thickener tank; pump to sludge storage tank (T-5) if necessary.
- Leave water in the Lamella unit.

4.4.8 Holding Tank and Pumps (T-2 and P-3, P-4, P-5)

Normal Operation of T-2

- Check the tank and piping for leaks.
- Check mixer for lubrication, noise, vibration, alignment and shaft motion. (Note: mixer will not regularly be used).
- Check pumps for lubrication, alignment, and rotation.
- Check pumps for unusual noise, vibrations, overheating, and leakage.
- Check pump motors for operating temperature and shaft motion.
- Check the pressures on the pump effluent. If pressure is high, shutdown pumps and clean check valves.

Shutdown of T-2

Operation of tank T-2 is necessary to pump process water into the activated sludge plant; therefore, T-2 should not be taken out of service unless the entire treatment system is shut down. The following is the procedure for shutting down T-2.

- Shut off activated sludge plant nutrient feed system pumps.
- Close fill valves to the tank.
- Make sure that the mixer is turned "Off." (Note: mixer will not regularly be used and should already be off).
- Shut off the pump by turning the respective control switch at the MCC to "Off" or by selecting "Off" in the computer control system when the control switch on the MCC is in the "Auto" position.
- Close all valves on the pump influent and effluent lines.
- Drain or pump the tank into the sump.

4.4.9 Activated Sludge Plant (ME-101)

Normal Operation of ME-101

Operation of the activated sludge plant should be conducted in accordance with the Activated Sludge Plant Operation and Maintenance Manual contained in Volume 10 of this manual. The following is a summary operating requirements needed to integrate ME-101 into the treatment system:

- Check for leaks in the tank, piping, and fittings.
- Perform process monitoring as specified.
- Verify operation of high level switch located in the clarifier effluent.
- Check operation of the chemical and nutrient addition systems. Collect routine COD samples to determine the flowrate of the required flowrate from these pumps to maintain a COD:Nitrogen:Phosphorous ratio of 100:5:1. Adjust if necessary.
- Verify operation of the blowers, air diffusion system and air lifts.
- Verify operation of the sludge rake in the clarifier.
- Adjust the sludge pump (P-102) cycle frequency and pumping rate as necessary.
- Observe clarifier effluent to ensure large amounts of solids are not escaping.
- Confirm operation of air lifts.
- Ensure clarifier effluent weir is level.

Shutdown of ME-101

The activated sludge plant should not be shut down for extended periods of time as this may destroy the microbial population. The system can be bypassed if needed for short periods of time. If the system does need to be shutdown, follow the Activated Sludge Plant Operation and Maintenance Manual contained in Volume 10 of this manual and the steps below.

- Ensure that process water is no longer entering ME-101.
- Shut off the air lifts, blowers, and clarifier sludge rake, if necessary. If possible, keep the return activated sludge air lift operating.
- Provide air to the microbial population via a diesel compressor to maintain dissolved oxygen levels if necessary.

4.4.10 Sand Filter (ME-7)

Normal Operation of ME-7

- Check the backwash flow rate and visually observe sand output of the airlift pump.
- Verify compressed air supply is on and the rotameter and pressure regulator are operational. Note: the rotameter and pressure regulator are typically bypassed during operation.
- Check the water level over the effluent weir.

Shutdown of ME-7

- If the entire system is to be shutdown, ensure that the extraction pumps, recycle pumps P-9 and P-10, and process pumps P-3, P-4, and P-5 are shutdown and that water is no longer flowing into ME-7, then close the ME-7 influent valves. If the entire system is not going to be shutdown, open the valves on the ME-7 bypass line and close the ME-7 influent valves.
- Turn off the backwash air at the filter control panel.
- Close the effluent valves.
- Drain or pump empty ME-7 if shutdown for a long period.

4.4.11 Holding Tank and Pumps (T-3 and P-6, P-7, P-8)

Normal Operation of T-3

- Check the tank and piping for leaks.
- Check mixer for lubrication, noise, vibration, alignment and shaft motion. (Note: mixer will not regularly be used).
- Check pumps for lubrication, alignment, and rotation.
- Check pumps for unusual noise, vibrations, overheating, and leakage.
- Check pump motors for operating temperature and shaft motion.
- Check the pressures on the pump effluent. If pressure is high, shutdown pumps and clean check valves. Check pumps for solids build up.
- Periodically check the pH sensor and chemical feed ports to ensure that the sensor and chemical feed lines are secure.
- Check mixer for lubrication, noise, vibration, alignment, and shaft motion.
- Verify operation and calibration of the pH sensor on a periodic basis.
- Verify pH control on the PLC.

Shutdown of T-3

Operation of tank T-3 is necessary to pump process water through the final treatment components and to the wetlands; therefore, T-3 should not be taken out of service unless the entire treatment system is shut down. Following is the procedure for shutting down T-3.

- Close fill valves to the tank.
- Make sure that the mixer is off.
- Shut off the chemical feed pumps.
- Shut off the pump by turning the respective control switch at the MCC to “Off” or by selecting “Off” in the computer control system when the control switch on the MCC is in the “Auto” position.
- Remove and clean the pH sensor and store in clean storage solution if the shut down is for more than a few days or anytime the sensor will not be submerged.
- Close all valves on the pump influent and effluent lines.

4.4.12 Ultraviolet Oxidation Unit (ME-2)

Normal Operation of ME-2

- Refer to manufacturer’s literature for regular operations and maintenance.
- Check the PLC for automatic operations.
- Check and maintain UV lamps. Replace UV lamps if required. Follow manufacturer’s instructions for UV lamp replacement.
- Perform process monitoring as specified.
- Ensure that the UV oxidation control panel is safe to operate and there are no leaks or water around the UV oxidation unit.

Shutdown of ME-2

- If the entire system is to be shutdown, ensure that the extraction pumps are shutdown and that water is no longer flowing into ME-2, then close the ME-2 influent valves. If the entire system is not going to be shutdown, open the valves on the ME-2 bypass line and close the ME-2 influent valves.
- Shut off the chemical feed systems (if being used).
- Follow manufacturer’s instructions for the oxidation unit shut off.

- Confirm the power supply to the UV oxidation unit is shut-off at the main breaker panel.

4.4.13 Pressure Sand Filter Beds (ME-8 and ME-9)

Normal Operation of the Sand Filter Beds

- Verify that all valves are set as described in the startup procedures.
- Verify pressure gauges on each unit are operational. If the differential pressure across either the lead or lag unit exceeds 10 psi, check the settings for the automatic backwash system.
- Perform routine process monitoring procedures as specified. If the units show poor performance, inspect the interior of the units in accordance with the filter media supplier's requirements and procedures.

Shutdown of the Sand Filter Beds

- Disable the automatic backwash system.
- Adjust the bypass valves to bypass the pressure sand filter bed(s) to be taken out of service. Note that the maximum flowrate through one unit is 30 gpm.
- For normal shut down of one sand filter bed, close inlet and discharge valves on the unit to be taken off service and verify that flow-through the off service unit has completely ceased (by observing the pressure gauge). Keep water in the units to prevent corrosion and disturbance of the filter media.
- For replacement of the filter media, follow the procedures for shut down of one unit. Contact the sand filter media supplier for media replacement.

4.4.14 Granular Activated Carbon (GAC) Units (ME-33 and ME-34)

Normal Operation of the GAC Units

- Identify the lead and lag contactor units during current operation.
- Verify that all valves are set as described in the startup procedures.
- Verify pressure gauges on each unit are operational. If the differential pressure across either the lead or lag unit exceeds 10 psi, perform backwash procedures as specified by the manufacturer's instructions.
- Perform routine process monitoring procedures as specified. If the lead unit shows poor performance, perform GAC replacement per manufacturer's instructions.

Shutdown of the Granular Activated Carbon Units

- Adjust the bypass valves to bypass the GAC unit(s) to be taken out of service.

- For normal shut down of one GAC unit, close inlet and discharge valves on the GAC unit to be taken off service and verify that flow-through the off service unit has completely ceased (by observing the pressure gauge). Keep water in the units to prevent corrosion and disturbance of the GAC.
- For replacement of spent carbon, follow the procedures for shut down of one GAC unit. Contact the carbon vendor for carbon replacement.

4.4.15 Effluent pH Adjustment System

Normal Operation of the Effluent pH Adjustment System

- Verify that adequate chemical solutions are available. Order fresh stock as needed.
- Verify that the chemical feed pumps are in “Auto” position.
- Inspect the static mixer to ensure that it is not clogged.
- Collect samples for on-site or laboratory analyses at the specified frequency.
- Calibrate pH sensor and flow meter on a regular basis.
- Monitor pH and flow at the control panel.
- Inspect the solenoid valves (SV-110A and SV-110B) to ensure that it transfers off-spec effluent to the Tank T-2. Ensure that the inlet valves to the Tank T-2 are open before transferring the off-spec effluent.
- Prepare operations log and other documents per the Performance Standard Verification Plan, 1997.

Shutdown of the Effluent pH Adjustment System

Operation of the effluent pH adjustment/monitoring system is necessary to regulate discharge of process water to the wetlands and; therefore, should not be taken out of service unless the entire treatment system is shut down. Following is the procedure for shutting down the effluent pH adjustment/monitoring system:

- Close the effluent discharge valve.
- Shut off the chemical feed pumps.
- Remove and clean the pH sensor and store in clean storage solution if the shut down is for more than a few days.

4.4.16 Oil/Non-Aqueous Phase Liquid Holding Tank (T-6)

Normal Operation of T-6

- Check the tank and piping for leaks.
- Check oil/LNAPL level in the storage tank.
- To remove accumulated oil/NAPL from the tank connect disposal truck and open effluent valves.

Shutdown of T-6

- Close valves on piping entering the tank.

4.4.17 Inorganic Sludge Holding Tank (T-5)

Normal Operation of T-5

- Confirm that high level switch in sludge storage tank is working.
- Adjust position of decant valves as necessary to decant liquid from the top of settled sludge.
- Check for leaks in the tank, piping, and fittings.

Shutdown of T-5

- Turn off the sludge transfer pump(s) (P-12, P-13, P-101) to the sludge storage tank by selecting "Off" on the HOA switch for each pump.
- Close inlet valves to the storage tank.
- Transfer contents of the tank into tank T-104 or dewater the solids in the filter press unit and close the tank outlet valve.

4.4.18 Organic Sludge Holding Tank (T-104)

Normal Operation of T-104

- Confirm that level switch in sludge storage tank is working.
- Adjust position of decant valves as necessary to decant liquid from the top of settled sludge.
- Check for leaks in the tank, piping, and fittings.

Shutdown of T-104

- Turn off the sludge transfer pump (P-102) to the sludge storage tank by selecting "Off" on the HOA switch for each pump.
- Close inlet valves to the storage tank.

- Transfer contents of the tank into tank T-5 or dewater the solids in the filter press unit and close the tank outlet valve.

4.4.19 Holding Tank and Pumps (T-1 and P-1, P-2)

Normal Operation of T-1

- Check the tank and piping for leaks.
- Inspect and maintain mixer ME-15 according to the manufacturers instructions (Note: mixer will not regularly be used).
- Check pumps for lubrication, alignment, and rotation.
- Check pumps for unusual noise, vibrations, overheating, and leakage.
- Check pump motors for operating temperature and shaft motion.
- Check the pressures on the pump effluent. If pressure is high, shutdown pumps and clean check valves.
- Check the water level in the tank. The tanks should be filled to the high level switch to ensure adequate water for the sand filter bed automatic backwash system.

Shutdown of T-1

- Close valves on piping entering the tank.
- Turn off mixer ME-15 (if running).
- Disable the sand filter bed automatic backwash system.
- Drain or pump the tank into the sump.

4.4.20 Recycle Holding Tank and Pumps (T-4 and P-9, P-10)

Normal Operation of T-4

- Check the tank and piping for leaks.
- Check pumps for lubrication, alignment, and rotation.
- Check pumps for unusual noise, vibrations, overheating, and leakage.
- Check pump motors for operating temperature and shaft motion.
- Check the pressures on the pump effluent. If pressure is high, shutdown pumps and clean check valves.

Shutdown of T-4

- Close valves on piping entering the tank.
- Drain or pump the tank into the sump.

4.4.21 Filter Press (ME-12)

Normal Operation of ME-12

- Clean equipment and general area.
- Perform maintenance on the sludge pumps.
- Perform dewatering procedures as required.
- Perform process monitoring procedures as specified.
- Coordinate sludge transport to off-site disposal facility.

Shutdown of ME-12

- Accelerated sludge handling may be required prior to an extended shut down.
- Turn “Off” the precoat mixing tank (T-12) mixer at the local panel and at the MCC.
- Shut off the precoat transfer pump (P-32) and the sludge transfer pump (P-14).
- Follow manufacturer’s instructions for the filter press shut off.

4.4.22 Chemical Feed Systems (Acid, Caustic, etc.)

The individual components of the chemical feed systems are lumped together and considered as parts of a single unit. The entire chemical feed system should be checked, started, and brought on-line at the same time. This method ensures integrity of the feed system as a complete unit and also allows for timely startup of the down-stream treatment processes that depend on the chemical feed system for an effective treatment.

Normal Operation of the Chemical Feed Systems

- Check the supply tanks, drums, totes and piping for leaks.
- Verify that chemical solutions are available. If needed, prepare fresh stock.
- Verify that the plant air is available and is set to the desired pressure value (if needed).
- Check metering pumps for unusual noise, vibrations, overheating, and leakage.
- Check metering pump motors for operating temperature.

- Check for leaks from the metering pumps and piping, particularly around valves and joints.
- Switch the pumps to “Auto” and check for proper PLC control.
- Verify the pumps are constructed of material compatible with the chemicals being used.

Shutdown of the Chemical Feed Systems

- Shut the pump off at the metering pump control panel.
- Check the motor for shaft or diaphragm motion.
- Close all valves on the influent and effluent lines.
- Drain and flush pumps.

4.4.23 Catalytic Oxidizer/Scrubber (ME-106)

Normal Operation of ME-106

ME-106 should be operated in accordance with the manufacturer’s operation and maintenance manual located in Volume 10 of this manual. Following are some additional key requirements:

- Ensure that the unit is in “Auto” mode.
- Verify that caustic solution, potable water, and natural gas are available.
- Ensure that the blowdown is being pumped to T-7 and that there is sufficient storage capacity in T-7.
- Monitor air flow and inlet and outlet temperature.
- Check chart recorder to ensure that it is functioning properly. Replace paper when needed. Store completed recorder strips in safe place.

Shutdown of ME-106

Follow the shutdown procedures detailed in manufacturer’s operation and maintenance manual located in Volume 10 of this manual. Following is the general procedure for shutdown of ME-106.

- Ensure that the unit is in “Off” mode.
- Ensure that the blower ME-102 shuts down. Also, note that when this blower shuts down, the remainder of the system will shutdown on a delayed basis.

- Shutoff caustic solution, potable water, and natural gas supply if during maintenance of ME-106 or if ME-106 will be shutdown for a prolonged period of time.
- Properly “lockout” ME-106 before any repairs are made.

4.4.24 Air Compressor (ME-24)

Normal Operation of the Air Compressors

- Check, clean, and replace air filters as necessary.
- Perform inspection and maintenance procedures on the compressors, dryers, and receivers as required by the equipment manufacturers.
- Verify pressure at the compressor, receiver, and local gauges on a periodic basis.
- Properly “lockout” air compressor before maintenance activities.

Shutdown of the Air Compressors

- Shut down air compressors locally. Turn control switch to the “Off” position.
- Turn air compressor switches at MCC to “Off.”
- Bleed air from receiver and air lines.
- Properly “lockout” air compressor before maintenance activities or during prolonged shutdown.

5.0 TROUBLE SHOOTING GUIDE

5.1 BARRIER WALL EXTRACTION SYSTEM

The BWES system consists of extraction pumps from the Off-Site Area and the On-Site Area. The pumps enter the GWTP header system through five separate influent lines (see Table 2-2 for a description of the influent lines) to allow the operator to change the extraction points based on hydraulic and contaminant and dewatering stage.

The entire BWES extraction system or any of the individual submersible BWES pumps might not operate properly for the following reasons:

1. No flow to the GWTP.
 - Pump discharge valve closed.
 - No electrical power to the GWTP and/or the individual pumps.
 - Extraction pump “Motor Minder” not operating properly.
 - Leak within pump vault.
 - Low water table in the extraction trench.
 - Alarms at the GWTP are activated.
 - The pump is damaged or burned out.
2. Excess flow to the GWTP.
 - Pump discharge valve open too far.
 - High water table in the extraction trench.
3. Contaminant concentrations too high.
 - Pump discharge valve open too far.
 - Pumping from wrong BWES pumps.

5.1.1 No Flow to the Groundwater Treatment Plant

Narrowing the Problem

1. Confirm there are no alarms activated at the GWTP that would disable the BWES pumps.
2. Confirm that the pump discharge valve(s) are open.
3. Check water level in or around the BWES extraction trench.
4. Confirm that the GWTP has electrical power.
5. Confirm that the pump’s local “Motor Minder” has electrical power.
6. Confirm that the pump is receiving electrical power from the “Motor Minder”.

7. Check pipe connections for leaks.
8. Check the pump for damage.
9. Determine if pump is coated with undesirable substance or clogged.

Corrective Actions

1. If one of the shutdown alarms at the GWTP is activated, then correct the alarm situation in accordance with the appropriate section of this manual.
2. If any of the pump discharge valves are closed, then open them.
3. If the GWTP does not have power, examine the circuit breaker box inside the GWTP to see if any circuits have been tripped. Remedy as needed.
4. If the water level in/around the extraction trench is below the level that the “motor minder” will allow the pump to operate, then the pumps are operating correctly. The target flowrate through the system (as pumped by pumps P-104 and P-105) can also be adjusted to achieve a better balance between the GWTP flowrate and the influent flowrate.
5. If the water level is within the pumping range, all of the valves are open, the GWTP is calling for the pumps to run, and there are no alarms, but the pump is not operating, then check the electrical connections of each pump and local control panel. The individual pumps may not be receiving power.
6. If the pump is operating, the water level is within the pumping range, all of the valves are open, the GWTP is calling for the pumps to run, and there are no alarms, but water is not reaching the GWTP, then there is potentially a leak in the piping or piping connectors. Inspect the visible piping and connections for evidence of leaks or damage. Arrange to fix any problems or conduct a subsurface investigation.
7. If the water level is within the pumping range, all of the valves are open, and there are no alarms, the pumps are receiving sufficient power, but the pumps are not operating, then:
 - The pump’s “motor minder” device may be broken. Repair or replace the “motor minder” in accordance with the manufacturer’s O&M manual located in Volume 9 of this manual.
 - The pump is damaged. Repair or replace the pump in accordance with the manufacturer’s O&M manual located in Volume 9 of this manual.
8. If the pump is coated with a substance that interferes with operation of the pump or cannot be removed, then the pump’s filter pack has failed. Replace or repair the

pump and install it in one of the contingency extraction wells along the trench in accordance with the Final Remedy.

5.1.2 Excess Flow to the Groundwater Treatment Plant

Narrowing the Problem

1. Check water level in or around the BWES extraction trench.
2. Check the position of the influent valves.
3. Review GWTP alarm log.

Corrective Action

The influent flowrate from the BWES can be decreased by throttling back the pump discharge valves at the pump or at the GWTP influent header system. If there have been several GWTP alarms or a long term shutdown of the GWTP, the BWES pumps will have been disabled for an extended period of time resulting in high pumping rates when initially reactivated. The component causing the alarm should be addressed in accordance with the appropriate section of this manual.

5.1.3 Contaminant Concentrations Too High

If the GWTP influent contaminant concentrations to the GWTP are above the design limits, the following corrective actions can be conducted:

1. Decrease the total BWES influent flowrate.
2. Decrease the flowrate from the specific BWES extraction wells where the contamination is greatest and increase the flowrate from the BWES extraction wells located near the barrier wall perimeter where the contaminant concentrations are lower. This can be done at the GWTP influent header.
3. Several of the BWES extraction wells in the Off-Site Area can be grouped in the field. Group the higher contaminated wells together and the lower contaminated wells together. Then decrease the flowrate from the high contamination grouping and increase the flowrate from the low contamination grouping at the GWTP influent header.

5.2 PERIMETER GROUNDWATER CONTAINMENT SYSTEM EXTRACTION SYSTEM

The entire PGCS extraction system or any of the individual PGCS pumps might not operate properly for the following reasons:

1. No flow to the GWTP.
 - Low level switches set to high.
 - High level switch set to low.
 - Pump discharge valve closed.

- No power to the pump(s).
 - Leak within pump vault.
 - Low water table in the extraction trench.
 - Pump burn out.
 - Alarms at the GWTP are activated.
 - Control levels in the aerated equalization tank (T-102) improperly set.
2. Excess flow to the GWTP.
 - Low level switches set to low.
 - High level switch set to low.
 - Pump discharge valve open too far.
 - High water table in the extraction trench.

5.2.1 No Flow to the Groundwater Treatment Plant

Narrowing the Problem

1. Confirm there are no alarms activated at the GWTP that would disable the PGCS pumps.
2. Confirm that the pump discharge valve(s) are open.
3. Check water level in or around the PGCS extraction trench.
4. Check pump power switch at the MCC.
5. Check pipe connections for leaks.
6. Confirm that the water level in T-102 is below the high level set point (LH2-102, LH3-102, and LH4-102) in T-102.

Corrective Actions

1. If one of the shutdown alarms at the GWTP is activated, then correct the alarm situation in accordance with the appropriate section of this manual and acknowledge the alarm.
2. If any of the pump discharge valves are closed, then open them.
3. If the pump power switch is in the "Off" position, then turn the pump to either "Auto" or "Hand" mode.
4. If the water level is above the high water level set point (LH2-102, LH3-102, or LH4-102) in T-102, the pump is operating correctly and will re-engage when the water level drops below the low level set point (LL2-102, LL3-102, or LL4-102; respectively).

5. If the water level is below the high water level set point (LH2-102, LH3-102, or LH4-102) in T-102 but above the low level set point (LL2-102, LL3-102, or LL4-102; respectively), either allow the water to drop below the respective low level set point or temporarily adjust the low level set point to a level higher than the current water level in T-102. If the pump(s) enable then they are operating correctly. If the pumps do not enable, then proceed with item 7 below.
6. If the water level in T-102 is below the low level set point (LL2-102, LL3-102, or LL4-102), then proceed with item 7 below.
7. If the water level in/around the extraction trench is below the “pump on,” then the pumps are operating correctly. If flow is desired, then lower the low level switch that disables the pump to a level that is below the groundwater level. If the pump continually cycles on and off, the high level switch for the extraction trench that enables the pump can be raised. This will result in longer pumping time then the pump is started. The target flowrate through the system (as pumped by pumps P-104 and P-105) can also be adjusted to achieve a better balance between the GWTP flowrate and the influent flowrate.
8. If the pumps is operating, the water level in the extraction trench is within the pumping range, all of the valves are open, and there are no alarms, but no PGCS water is reaching the GWTP, then there is a leak in the piping or piping connectors. Inspect the visible piping and connections for evidence of leaks or damage. Arrange to fix any problems or conduct a subsurface investigation to identify and fix the problems.
9. If the water level is within the pumping range in the extraction trench, all of the valves are open, and there are no alarms, the pumps are receiving electrical power, but the pumps are not operating; then repair or replace the damaged pumps in accordance with the manufacturer’s O&M manual located in Volume 9 of this manual.

5.2.2 Excess Flow to the Groundwater Treatment Plant

Narrowing the Problem

1. Check water level in or around the PGCS extraction trench.
2. Check the high and low level pump operation switches.
3. Check the position of the influent valves.
4. Review GWTP alarm log.

Corrective Action

The influent flowrate from the PGCS can be decreased by either throttling back the pump discharge valve, raising the high and low level pump operation switches in the extraction trench(es), or raising the high and low level pump operation levels in the aerated equalization tank (T-102). Both of these actions can be used. If there have been several GWTP alarms or a long term shutdown of the GWTP, the PGCS pumps will have been

disabled for an extended period of time resulting in high pumping rates when initially reactivated. The component causing the alarm should be addressed in accordance with the appropriate section of this manual.

5.3 IN-SITU SOIL VAPOR EXTRACTION CONDENSATE COLLECTION SYSTEM

This section will be updated during installation of the ISVE systems.

5.4 GRAVITY PHASE SEPARATOR (T-101)

The gravity phase separator is the first of the NAPL removal components of the GWTP. The purpose of the oil/water separator is to remove free oil and suspended solids from the BWES water and ISVE condensate. The design flowrate through T-101 is 30 gpm.

The BWES influent pumps and the ISVE condensate transfer pumps pump process water through the influent header system and directly into the gravity phase separator from the field. Effluent groundwater from the oil/water separator flows by gravity to the mixing tank (T-103). The oil collected in the separator flows by gravity through one of the decant ports to the waste oil holding tank (T-6). Some solids settle and accumulate in the cone bottom of the tank. These solids will be pumped using a pneumatically driven double diaphragm sludge pump (P-101) to the inorganic sludge holding tank (T-5).

The oil/water separator might not operate properly for the following reasons:

1. Oil build up in the separator.
 - Closed valve.
 - Plugged piping.
2. Suspended solids buildup.
 - Closed valve.
 - Plugged piping.
 - Sludge pump P-101 not operating.
 - Sludge pump P-101 not operating frequently enough.
 - PLC malfunctioning.
3. High water level in tank.
 - Closed effluent valve.
 - Plugged piping.
 - Influent flowrate too high.

5.4.1 Oil Build Up

Narrowing the Problem

Confirm that one of the valves on the decant ports is open and the valve in the influent line to the waste oil holding tank (T-6) is open. If a decant port-valve is open, open the next valve down. Continue until oil discharges or all of the valves are open.

Corrective Action

If oil is building up and the valves are open, then the line to the waste oil holding tank is plugged. The line must be cleaned.

5.4.2 Suspended Solids Buildup

Narrowing the Problem

1. Confirm that the valves in the pipe to the inorganic sludge holding tank (T-5) are open.
2. Confirm that the pump P-101 selector switches are in the "Hand" or "Auto" positions. If the pump is not in "Hand" position, turn pump to "Hand" to confirm that the pump operates. If the pump does not operate in the "Hand" position, check if the air compressor (ME-24) is operating and that the solenoid valve to P-101 is open. If the air compressor is working and the solenoid valve is open, then follow the trouble shooting guide in the pump manufacturer's manual (Volume 9).
3. Confirm that the timer in the MMI/PLC is set correctly.
4. Confirm that suspended solids are not built up to the extent that excessive suspended solids are flowing to the mixing tank.

Corrective Actions

1. If suspended solids are building up, the valves are open, and pump P-101 will operate, then the pipe to the sludge holding tank should be cleaned to eliminate any plugging.
2. If suspended solids are building up, valves are open, and pump P-101 will not operate, then the pump needs repair, the air supply system (air compressor ME-24 and solenoid valve), or the PLC is preventing the pump from operating. First check the air supply system. Second confirm that the pump is not damaged or that the gaskets are worn and leaking air. If needed, contact an electrician to confirm whether the PLC is preventing the pump from operating.
3. If the valves are open and pump P-101 works in "Hand" mode but not in "Auto" mode, the timer in the PLC is not operating correctly. Reset the timer to pump for a short duration and monitor if the pump pumps. If resetting the timer does not work, contact an electrician to confirm whether the PLC is preventing the pump from operating.

4. If the valves are open, pump P-101 works, and the timer in the PLC works but suspended solids are still building up, increase the pumping frequency or duration with the timer at the MMI.
5. If excessive suspended solids are exiting T-101 and entering the mixing tank (T-3), decrease or stop the influent flowrate from the field pumps until the corrective actions mentioned above are successfully completed.

5.4.3 High Water Level

Narrowing the Problem

1. Confirm that the valves in the pipe to the mixing tank (T-103) are open.
2. Confirm that T-3 is not overflowing.
3. Check if high level alarm LAH-101 is activated.

Corrective Actions

1. If LAH-101 is activated, the effluent valves are open, and T-103 is not overflowing, then temporarily disable the field pumps discharging to T-101. If the water level drops quickly then the influent flowrate to T-101 is too high and the flowrate should be decreased. If the water level does not drop quickly then the pipe to T-103 is plugged and should be cleaned.
2. If LAH-101 is activated, the effluent valves are open, and T-103 is overflowing, then temporarily disable the field pumps discharging to T-101 and see the section for trouble shooting the mixing tank T-103.
3. If LAH-101 is not activated, then temporarily disable the field pumps discharging to T-101. Clean the level switch (LSH-101) and manually activated it. If LAH-101 is activated then re-enable the field pumps and increase the cleaning frequency of the switch. If LAH-101 is not activated, then contact an electrician to determine why the alarm signal is not being processed by the PLC.

5.5 MIXING TANK (T-103)

The purpose of mixing tank is to adjust the influent pH to approximately 4 S.U. with the addition of sulfuric acid.

Sulfuric acid is fed from the sulfuric acid storage tank (T-9) to the mixing tank (T-103) by sulfuric acid metering pump (P-18). The pumping rates of the metering pumps are regulated by the 4-20 mA output signal from the pH controller (CE/CIC-103). This signal is transmitted to the PLC where the operator inputs the desired pH level (~4 S.U.) at the MMI. The PLC then transmits the required pumping rate to the metering pumps. The sulfuric acid metering pump turns on when the pH is above the target set point. The pumping rate is automatically set in proportion to the deviation from the target set point. The metering pump shuts off when the pH in T-3 reaches the target value.

The pH adjustment system might not operate properly for the following reasons.

1. High pH

- Influent process water pH is excessively high.
- The sulfuric acid metering pump selector switches are set to “Off” position.
- Sulfuric acid pumping stroke setting is too low.
- Sulfuric acid pumping system is not functioning properly, possibly due to:
 - Plugged piping
 - A Broken pump
 - A Closed valve
 - Leaking acid suction tubing
- Sulfuric acid supply is low.
- pH controller is not operating properly.
- Mixer is not operating.
- pH sensor is dirty or needs calibration.
- The 4-20 mA signals are set incorrectly at the PLC/MMI.

2. Low pH

- Sulfuric acid metering pump selector switches are set to “Manual” position.
- Sulfuric acid metering pump touch pad has been set to pump at a constant rate rather than accept a 4-20 mA signal from the PLC.
- Mixer is not operating.
- pH sensor is dirty or needs calibration.
- pH controller is not operating properly.
- The 4-20 mA signals are set incorrectly at the PLC/MMI.
- Influent process water pH is excessively low.

3. Tank overflows.

- Closed effluent valve.
- Plugged piping.
- Influent flowrate too high.

4. De-emulsifier is not being added.

- De-emulsifier supply level is low.
- De-emulsifier metering pump selector switches are in the “Off” position.
- De-emulsifier metering pump stroke setting is too low.
- De-emulsifier pumping system is not functioning properly, possibly due to:
 - Plugged piping
 - A Broken pump
 - A Closed valve
 - Leaking caustic suction tubing
- De-emulsifier metering pump not correctly receiving flowrate at flowmeter FM-108 from the PLC.

5.5.1 High pH

Narrowing the Problem

1. Check pH in T-103 (near the pH sensor) and T-103 influent with a portable pH sensor or pH paper.
2. Confirm that there is sulfuric acid in the sulfuric acid storage tank (T-9).
3. Clean and calibrate the pH sensor (CE-103).
4. Determine whether sulfuric acid is being pumped by observing the sulfuric acid pipe at the mixing tank.
5. Confirm that sulfuric acid pump selector switches are in the "Manual" or "Auto" positions.
6. Confirm that the mixer (ME-103) is working.
7. Confirm that the metering pump is set to receive a 4-20 mA signal from the PLC.
8. Check the set points for the 4-20 mA signal from the pH controller to the PLC.
9. Check the set points for the PID control loop.
10. Test the pH sensor's automatic wash system.

Corrective Actions

1. If the pH measured with the portable pH sensor is greatly different than the pH reading by CE-103, then either the CE-103 sensor is dirty, needs calibrating, or is not operating properly. Clean and recalibrate CE-103. If the pH reading by the cleaned sensor begins to match the portable pH sensor reading, then increase the frequency of maintenance for CE-103. If the pH still varies from the portable pH sensor, then CE-103 is potentially damaged and should be repaired or replaced. Increase the frequency of the pH sensor's automatic wash system if the sensor repeatedly fouls due to residue or film.
2. If the sulfuric acid level in T-9 is low and/or the low level alarm in T-9 (LAL-9) is activated, order more acid.
3. If the set points for the 4-20 mA signal from the pH controller to the PLC are not set correctly (4 mA = 0 S.U.; 20 mA = 14 pH), reset them correctly.
4. If the set points for the PID control loop are not set correctly, then set them in accordance with Table 4-1.

5. If sulfuric acid is not being pumped and the pH in T-3 is above the target level, then insure that the sulfuric metering pumps are in either “Auto” or “Manual” mode and that the acid supply piping is not plugged or leaking, does not contain air blocks, and all of the valves are open. If sulfuric acid is still not being pumped, the sulfuric acid metering pump may be damaged. Follow the troubleshooting procedures in the metering pump manufacturer’s manual (Volume 9).
6. If the sulfuric acid metering pumps are in “Auto” mode, sulfuric acid is being pumped, and the pH is still above the set point, then the pumping stroke length on the sulfuric acid metering pumps needs to be increased. Ensure that the pH begins to drop to the target level.
7. If mixer is not working, ensure that the mixer (ME-103) is receiving electrical power. If the mixer is receiving electrical power but is not working, follow the troubleshooting procedures in the mixer manufacturer’s manual (Volume 9).

5.5.2 Low pH

Narrowing the Problem

1. Check pH in T-103 (near the pH sensor) and T-103 influent with a portable pH sensor or pH paper.
2. Confirm that there is sufficient sulfuric acid in the storage tank (T-9).
3. Clean and calibrate the pH sensor.
4. Determine whether sulfuric acid is being pumped by observing the sulfuric acid pipe at the mixing tank.
5. Confirm that the sulfuric acid metering pump selector switches are in the “Auto” or “Off” positions.
6. Confirm that the metering pump is set to receive a 4-20 mA signal from the PLC.
7. Confirm that the mixer (ME-103) is working.
8. Check the set points for the 4-20 mA signal from the pH controller to the PLC.
9. Check the set points for the PID control loop.
10. Test the pH sensor’s automatic wash system.

Corrective Actions

1. If the pH measured with the portable pH sensor is greatly different than the pH reading by CE-103, then either the CE-103 sensor is dirty, needs calibrating, or is not operating properly. Clean and recalibrate CE-103. If the pH reading by the

cleaned sensor begins to match the portable pH sensor reading, then increase the frequency of maintenance for CE-103. If the pH still varies from the portable pH sensor, then CE-103 is potentially damaged and should be repaired or replaced. Increase the frequency of the pH sensor's automatic wash system if the sensor repeatedly fouls due to residue or film.

2. If the caustic level in T-8 is low and/or the low level alarm in T-8 (LAL-8) is activated, order more caustic.
3. If the sulfuric acid metering pumps are set to "Manual" mode, reset them to "Auto" mode. Ensure that the sulfuric acid metering pumps stop and that the pH begins to rise to the target pH. If the sulfuric acid metering pump does not stop pumping ensure that they are set to pump based on the PLC signal and not at a constant rate.
4. If mixer is not working, ensure that the mixer (ME-103) is receiving electrical power. If the mixer is receiving electrical power but is not working, follow the troubleshooting procedures in the mixer manufacturer's manual (Volume 9).
5. If the set points for the 4-20 mA signal from the pH controller to the PLC are not set correctly (4 mA = 0 S.U.; 20 mA = 14 S.U.), reset them correctly.
6. If the set points for the PID control loop are set incorrectly, then set them using Table 4-1 as a guideline.

5.5.3 Tank Overflows

Narrowing the Problem

1. Confirm that the valves in the pipe to the CPI oil/water separator (ME-1) are open.
2. Confirm that ME-1 is not overflowing.

Corrective Action

1. If the T-103 effluent valves are open, and ME-1 is not overflowing, then temporarily disable the field pumps discharging to T-101. If the water level drops quickly then the influent flowrate to T-101 is too high and the flowrate should be decreased. If the water level does not drop quickly then the pipe to ME-1 is plugged and should be cleaned.
2. If ME-1 is overflowing, then temporarily disable the field pumps and recycle pumps (P-9 and P-10) discharging to T-101 and see Section 5.6.

5.5.4 De-emulsifier is Not Being Added

Narrowing the Problem

1. Confirm that there is de-emulsifier in the storage tote.
2. Determine whether de-emulsifier is being pumped by observing the de-emulsifier pipe at the mixing tank.

3. Confirm that the de-emulsifier pacemaker pump selector switch is in the “Manual” or “Auto” positions.
4. Confirm that the pacemaker pump (P-107) is plugged in.
5. Confirm that the pacemaker pump is set to receive a 4-20 mA signal from the PLC.
6. Confirm that the flowmeter FM-108 is operating.
7. Check the set points for the 4-20 mA signal from the flowmeter (FE/FIT-108) to the PLC.
8. Check the set points for the 4-20 mA signal from the PLC to the de-emulsifier pacemaker pump.

Corrective Actions

1. If the de-emulsifier level in the storage tote is low, order more de-emulsifier and change the tote.
2. If flowmeter FM-108 is not measuring any flow, then determine if there is flow through the meter. If there is no flow, then P-107 is not pumping because there is no flow. If there is flow through the pipe, then FM-108 needs to be cleaned, repaired or replaced in accordance with the manufacturer's owner's manual (in Volume 9 of the manual).
3. If de-emulsifier is not being pumped and FM-108 is reading flow, then insure that the de-emulsifier pacemaker pump is in either “Auto” or “Manual” mode and that the de-emulsifier supply piping is not plugged or leaking, does not contain air blocks, and all of the valves are open. If de-emulsifier is still not being pumped, the de-emulsifier pacemaker pump may be damaged. Follow the troubleshooting procedures in the metering pump manufacturer's manual (Volume 9).
4. If not enough de-emulsifier is being pumped and FM-108 is reading flow, then confirm that P-107 is in “Auto” mode, is set to receive a 4-20 mA signal from the PLC, and that the de-emulsifier supply piping is not partially plugged or leaking and that all of the valves are completely open. If the P-107 settings are correct and the piping is fine, then increase the pumping stroke on the pump.
5. If the set points for the 4-20 mA signal from the flowmeter to the PLC are not set correctly (See Table 4-1 for initial system set points), reset them correctly.
6. If the set points for the 4-20 mA signal from the PLC to the metering pump are not set correctly (See Table 4-1 for initial system set points), reset them correctly.

5.6 CORRUGATED PLATE INTERCEPTOR OIL/WATER SEPARATOR (ME-1)

The purpose of ME-1 is to remove emulsified LNAPLs and DNAPLs from the process water. Process water flows by gravity into ME-1 from mixing tank T-103 where a de-emulsifying agent is added and the pH is dropped. Effluent from ME-1 combines with the cleaner GWTP influent and discharges to the aerated equalization tank (T-102). Separated oil flows by gravity to the oil holding tank (T-6) and collected sludge is pumped by a pneumatically-driven double diaphragm sludge pump (P-12).

Potential problems that could occur at ME-1 are:

1. Oil in effluent.
 - Influent flow rate is too great.
 - Excess oil over separator pack.
 - Target pH in T-103 is not reached.
2. Solids in effluent.
 - Influent flow rate is too great.
 - Sludge buildup in hoppers.
 - Target pH in T-103 is not reached.
 - Insufficient de-emulsifier was added in T-103.
3. Low solids content in sludge stream
 - Sludge pumped too often.
 - Sludge pumped is on "Hand" mode.
4. Unit Overflows.
 - Closed effluent valve.
 - Plugged piping.
 - Influent flowrate too high.

5.6.1 Oil in Effluent

Narrowing the Problem

1. Check the influent flow rate at flowmeter FM-108.
2. Confirm that the valves from the oil discharge pipe to T-6 are open.
3. Confirm that the target pH is being obtained in T-103.

Corrective Actions

1. If the influent flow rate is greater than 30 gpm, then decrease influent flowrate to T-101.
2. If the pH is not at the target set point, begin trouble shooting procedures for T-103 (Section 5.5).

3. If oil is overflowing the effluent weir and the valves in the oil discharge pipe are open, then the oil discharge pipe may be plugged. Clean the pipe to remove the plug.
4. If oil is overflowing the effluent weir, the valves in the oil discharge pipe are open, and the oil discharge pipe is not plugged, then adjust the separator pack depth to allow the oil to drain adequately.
5. If the influent flow rate is less than 30 gpm, all of the valves in the oil discharge pipe are open, the pipes are not plugged, and oil is adequately draining from the separator pack, then either decrease the influent flowrate or adjust the effluent weir to accept the flowrate.

5.6.2 Sludge in Effluent

Narrowing the Problem

1. Check the influent flow rate at flowmeter FM-108.
2. Confirm that the valves from the sludge discharge pipe to T-5 are open.
3. Confirm that pump P-12 is in either "Auto" or "Hand" mode.
4. Confirm that the target pH is being obtained in T-103.
5. Confirm that de-emulsifier is being added in T-103.

Corrective Actions

1. If the influent flow rate is greater than 30 gpm, then decrease influent flowrate to T-101.
2. If the pH is not at the target set point or de-emulsifier is not being injected, begin trouble shooting procedures for T-103 (Section 5.5).
3. If suspended solids are building up, the valves are open, and pump P-12 will operate, then the pipe to the organic sludge holding tank (T-5) should be cleaned to eliminate any plugging.
4. Confirm that the pump P-12 selector switches are in the "Hand" or "Auto" positions. If the pump is not in "Hand" position, turn pump on to confirm that the pump operates. If the pump does not operate in the "Hand" position, check if the air compressor (ME-24) is operating and that the solenoid valve to P-12 is open. If the air compressor is working and the solenoid valve is open, then follow the trouble shooting guide in the pump manufacturer's manual (Volume 9).
5. If suspended solids are building up, valves are open, and pump P-12 will not operate, then the pump needs repair, the air supply system (air compressor ME-24 and solenoid valve), the PLC is preventing the pump from operating. First check the air supply system. Second confirm that the pump is not damaged or that the gaskets are worn and leaking air. If needed, contact an electrician to confirm whether the PLC is preventing the pump from operating.

6. If the valves are open and pump P-12 works in “Hand” mode but not in “Auto” mode, the timer switch is not operating correctly. Reset the timer switch. If resetting the timer switch does not work, contact an electrician to confirm whether the PLC is preventing the pump from operating.
7. If the valves are open, pump P-12 works, and the timer switch works but suspended solids are still building up, increase either the pumping frequency or duration with the timer at the MMI.
8. If excessive suspended solids escaping over the effluent weir, then decrease or stop the influent flowrate from the field pumps until the corrective actions mentioned above are successfully completed.

5.6.3 Low Solids Content in Sludge Stream

Narrowing the Problem

1. Confirm that sludge pump P-12 is in “Auto” mode.
2. Confirm that de-emulsifier is being added to T-103.
3. Monitor the pH in T-103.

Corrective Action

1. If P-12 is on “Hand” mode, then turn selector switch to “Auto” mode.
2. If P-12 is on “Auto” mode, then increase the time between successive pumping of sludge to T-5.
3. If the pH is not at the target set point or de-emulsifier is not being injected, begin trouble shooting procedures for T-103 (Section 5.6).

5.6.4 Unit Overflows

Narrowing the Problem

1. Confirm that the valves in the pipe to the aerated equalization tank (T-102) are open.
2. Confirm that T-102 is not overflowing.

Corrective Action

1. If the ME-1 effluent valves are open, and T-102 is not overflowing, then temporarily disable the field pumps discharging to T-101. If the water level drops quickly then the influent flowrate to T-101 is too high and the flowrate should be decreased. If the water level does not drop quickly then the pipe to T-102 is plugged and should be cleaned.

5.7 AERATED EQUALIZATION TANK (T-102)

The purpose of the aerated equalization tank (T-102) is to assist in regulating the flow rate and contaminant concentration fluctuations to the activated sludge plant, remove VOCs and SVOCs, and to oxidize iron present in the groundwater. Groundwater enters T-102 from the CPI oil/water separator effluent or directly from the field pumps. Following groundwater equalization and aeration in T-102, groundwater is pumped to the chemical precipitation unit (lamella clarifier) by pumps (P-104 and P-105). These pumps are controlled primarily by a level controller (LE-102) in the equalization tank but can be automatically shut off if any one of many alarm conditions set in the PLC are met.

The equalization tank might not operate properly for the following reasons:

1. Tank overflows or high level alarm sounds.
 - Level controller (LE-102) is not working properly.
 - PLC malfunctions.
2. Water is not being pumped out of T-102.
 - Valves are closed.
 - Level controller (LE-102) is not working properly.
 - Piping is plugged.
 - Pumps are off or not operating.
 - Sludge has built up in the tank and/or effluent piping.
 - PLC malfunctions.
3. Insufficient diffused air in tank.
 - Blower ME-105 not operating.
 - Holes on the diffusers are plugged.
 - Catalytic Oxidizer/Scrubber (ME-106) is not operating.
 - Demister is plugged.
4. Excess foaming.
 - Defoamer supply level is low.
 - Defoamer metering pump (P-108) selector switches are in the "Off" position.
 - Defoamer metering pumping stroke length setting is too low.
 - Defoamer pumping system is not functioning properly, possibly due to:
 - plugged piping
 - a broken pump
 - a closed valve
 - Leaking caustic suction tubing
 - Defoamer metering pump not correctly receiving flowrate at flowmeter FM-108 from the PLC.
 - Incorrect defoamer being used.
 - The 4-20 mA signals are set incorrectly at the PLC/MMI.

5. Pressure build-up in T-102
 - Blower ME-105 pressure switch not working.
 - Catalytic Oxidizer/Scrubber (ME-106) is not operating.
 - Demister is plugged.

5.7.1 Tank Overflows or High Level Alarm Sounds

Narrowing the Problem

1. If water is overflowing and the alarm is not on, determine whether the tank level reading is correct. Confirm that the set points for the 4-20 mA signal from the level sensor (LE/LIT-102) to the PLC match the set points in Table 4-1.
2. If the high level alarm (LAH-101) is on, determine if the field pumps are still pumping (even though the tank level is high).

Corrective Actions

1. If the set points for the 4-20 mA signal from the level sensor (LE/LIT-102) to the PLC are incorrect, then reset them to match the set points in Table 4-1.
2. If the tank is overflowing, the alarm is not on, and the tank level reading is incorrect, then disable the field pumps and recycle (P-9 and P-10) and repair or replace the level transducer following the level controller manufacturer's manual (Volume 9).
3. If the tank is overflowing, the alarm is not on and the tank level reading is correct, then the PLC is not relaying the alarm status. Disable the field pumps and recycle (P-9 and P-10) and contact an electrician to determine why the PLC is not operating properly.
4. If the tank is overflowing, the alarm is on, and the tank level reading is correct, then the control panel is not relaying the disable signals to the field pumps. Manually disable the field pumps and recycle (P-9 and P-10) and contact an electrician to determine why the PLC is not operating properly.

5.7.2 Water is Not Being Pumped from the Tank

Narrowing the Problem

1. Determine whether the tank level reading is correct.
2. Confirm that the set points for the 4-20 mA signal from the level sensor (LE/LIT-102) to the PLC match the set points in Table 4-1.
3. Confirm that the water level in the tank is above the "pump on" level (LL1-102).
4. Confirm that the T-102 effluent valves are open.

5. Confirm that the pump(s) selector switches are in the “Hand” or “Auto” positions. If the pumps are not in the “Hand” position, turn them to “Hand” and confirm that they operate.
6. Confirm that flowmeter FM-803 is operating and that the desired flowrate is set at the MMI.
7. Confirm that no process alarms are activated.
8. Monitor the pressures at the pump influent and pump effluent.

If there is sufficient groundwater in the tank for the level controller (LE-102) to activate P-104 or P-105 and the selector switches for the pumps are in the “Hand” or “Auto” positions, then proceed as follows:

Corrective Actions

1. Determine whether P-104 and P-105 are operating.
2. If the set points for the 4-20 mA signal from the level sensor (LE/LIT-102) to the PLC are incorrect, then reset them to match the set points in Table 4-1.
3. If the pump(s) are operating then either the pump(s) or piping is plugged, the pump(s) needs to be repaired, or the flowrate setting is too low.
4. If the pump is not operating and no process alarms are activated, then the pump(s) need repair or the PLC is preventing the pump(s) from operating. Follow the trouble shooting procedures in the pump manufacture’s manual (Located in Volume 9 of this manual) and contact an electrician to confirm whether the PLC is preventing the pump from operating.
5. If the pump is not operating and one or more alarms are activated, then determine the source of the alarm and proceed in accordance with the appropriate section of this manual.
6. If the pressure at the pump effluent is significantly greater than the influent pressure, then disable the pumps, close the isolation valves, and clean the check valve on the pump effluent.

If there is insufficient groundwater in the tank (below LL1-102) but the pump(s) continue to run, then proceed as follows:

Corrective Actions

1. Confirm that the influent pumps are in “Auto” mode. If the pumps are in “Hand” mode, turn the selector switch to “Auto” mode.

2. Determine whether the tank level reading is correct.
3. If the tank level reading is incorrect, then disable the pumps (P-104 and P-105) and re-calibrate or replace the level transducer following the level controller manufacturer's manual (Volume 9).
4. If the tank level reading is correct, then confirm that the tank has not become partially filled with sludge.
5. If the level control reading is correct and the tank has not accumulated sludge, then the PLC is not operating properly. Contact an electrician to determine why the PLC is not operating properly.

5.7.3 Insufficient Diffused Air

Narrowing the Problem

1. Determine if the blower (ME-105) is operating.
2. Determine if the catalytic oxidizer/scrubber (ME-106) is operating.
3. Determine if the low air flow alarm is activated.
4. Determine if the diffusers are plugged.
5. Determine if the demister is plugged.

Corrective Actions

1. Blower ME-105 and the CAT-OX unit (ME-106) are interlocked. If one unit shuts down, the PLC will send a signal to the other unit to shutdown. Check the ME-106 local control panel for alarms. If the shutdown of blower ME-105 was caused by ME-106 then proceed to Section 5.23 for trouble shooting procedures for ME-106. Correct startup of ME-106 will automatically start up blower ME-105.
2. If the cause for the shutdown in the blower and the low air pressure alarm (PAL-105) has been activated, then follow the troubleshooting procedures in the blower manufacturer's owners manual (Volume 9) to determine why the blower is not operating. The blower needs to be restarted by ME-106.
3. If the blower is not operating and the low air pressure alarm has not been activated, then determine if the low air pressure switch (PS-105) is damaged. If the switch is damaged, then replace it and follow the troubleshooting procedures in the blower manufacturer's owners manual to determine why the blower is not operating. If the switch is not damaged, then contact an electrician to determine why the PLC is not relaying the alarm status correctly and follow the troubleshooting procedures in the blower manufacturer's owners manual (Volume 9) to determine why the blower is not operating.
4. If the blower is operating but insufficient diffused air is reaching the tank, check the blower discharge line to determine whether there are any leaks at welds, bends, etc. If there is an air leak, shut blower down and repair the leak. If there is no air leak,

the diffusers are plugged, or the blower is not operating properly. Drain the tank and either clean or replace the diffusers.

5. If the demister is plugged, high air pressure in T-102 will shut down blower ME-105. If the demister is plugged, clean or replace the demister filter media and restart the system.

5.7.4 Excessive Foaming

Narrowing the Problem

1. Confirm that there is defoamer in the storage drum/tote.
2. Determine whether defoamer is being pumped by observing the influent line to the defoamer metering pump.
3. Confirm that the defoamer metering pump (P-108) selector switches are in the "Manual" or "Auto" positions.
4. Confirm that the defoamer metering pump is plugged in.
5. Confirm that the metering pump is set to receive a 4-20 mA signal from the PLC.
6. Confirm that the flowmeter FM-803 is operating.
7. Confirm that the set points for the 4-20 mA signal from FM-803 to the PLC match the set points in Table 4-1.
8. Confirm that the set points for the 4-20 mA signal from the PLC to the defoamer metering pump (P-108) match the set points in Table 4-1.

Corrective Actions

1. If the defoamer level in the storage tote/drum is low, order more defoamer and change the tote/drum.
2. If flowmeter FM-803 is not measuring any flow, then determine if there is flow through the meter. If there is no flow, then metering pump P-108 is not pumping defoamer because there is no process flow. If there is flow through the pipe then FM-803 needs to be cleaned, repaired, or replaced in accordance with the manufacturer's owner's manual (in Volume 5 of the manual).
3. If the set points for the 4-20 mA signal from FM-803 to the PLC do not match the set points in Table 4-1, then readjust the set points to match Table 4-1.
4. If the set points for the 4-20 mA signal from the PLC to the defoamer metering pump (P-108) do not match the set points in Table 4-1, then readjust the set points. If the set points are set according to Table 4-1 and the metering pump is pumping defoamer but there is still a defoaming problem, then either increase the stroke

length of the metering pump or adjust the 20 mA set point to correspond to a lower flowrate (do not adjust by more than 5 gpm at a time).

5. If defoamer is not being pumped and FM-803 is reading flow, then insure that the defoamer metering pump is in either "Auto" or "Manual" mode and that the defoamer supply piping is not plugged or leaking, does not contain air blocks, and all of the valves are open. If pumping defoamer is still not being pumped, the pumping defoamer metering pump may be damaged. Follow the troubleshooting procedures in the metering pump manufacturer's manual (Volume 5).
6. If not enough defoamer is being pumped and FM-803 is reading flow, then confirm that P-108 is in "Auto" mode, are set to receive a 4-20 mA signal from the PLC, and that the defoamer supply piping is not partially plugged or leaking and that all of the valves are completely open. If the P-108 settings are correct and the piping is fine, then increase the pumping stroke on the pumps.

5.7.5 Pressure Build-up in T-102

Narrowing the Problem

1. Inspect the demister for blockage.
2. Inspect the blower ME-105 high pressure shutoff switch for damage.
3. Determine if the catalytic oxidizer/scrubber (ME-106) is operating.

Corrective Actions

1. If the demister is clogged, then clean or replace the demister and restart system.
2. If the blower ME-105 high pressure shutoff switch is damaged, then repair or replace the switch.
3. If the catalytic oxidizer/scrubber is not operating, refer to Section 5.23 and contact an electrician to determine why blower ME-105 was not automatically shutdown.

5.8 LAMELLA CLARIFIER (ME-6)

The chemical precipitation unit consists of the rapid mix tank (ME-4) and mixer (ME-18), the flocculation tank (ME-5) and mixer (ME-18), the lamella clarifier (ME-6) and sludge rake (ME-19), and the associated pH adjustment system and sludge pump. The combined unit is often known simply as the lamella clarifier.

For optimum metals removal in the lamella clarifier, the pH in the process water should be approximately 8.5 S.U. This pH is obtained by a pH adjustment system. Caustic is fed to ME-4 from the caustic storage tank (T-8) by caustic metering pump (P-109), if necessary. The pumping rate of the metering pump is regulated by the 4-20 mA output signal from the pH controller (CE/CIC-102). This signal is transmitted to the PLC where the operator inputs the desired pH level at the MMI. The PLC then transmits the required pumping rate

to the metering pump. The caustic metering pump turns on when the pH is below the target set point. The pumping rate is automatically set in proportion to the deviation from the target set point. The metering pump shuts off when the pH in ME-4 reaches the target value.

The chemical precipitation unit might not operate properly for the following reasons:

1. High pH
 - Influent groundwater pH is excessively high.
 - Caustic metering pump selector switches are set to "Manual" position.
 - Caustic metering pump touch pad has been set to pump at a constant rate rather than accept a 4-20 mA signal from the PLC.
 - pH controller is not operating properly.
 - pH sensor is dirty or needs calibration.
 - Mixer is not operating.
 - The 4-20 mA signals are set incorrectly at the PLC/MMI.
2. Low pH
 - Caustic supply level is low.
 - Caustic metering pump selector switches are in the "Off" position.
 - Caustic metering pumping stroke setting is too low.
 - Caustic pumping system is not functioning properly, possibly due to:
 - Plugged piping
 - A Broken pump
 - A Closed valve
 - Leaking caustic suction tubing
 - Mixer is not operating.
 - pH sensor is dirty or needs calibration.
 - pH controller is not operating properly.
 - The 4-20 mA signals are set incorrectly at the PLC/MMI.
3. Poor flocculation.
 - Waste characteristics have changed.
 - pH is incorrect.
 - Polymer solutions are not being added at the correct dosage.
 - Polymer pump rate is incorrect or pump is not operating.
 - Polymer solution concentration is incorrect.
4. Polymer blending system is malfunctioning.
 - Valve on water supply does not open or close correctly.
 - Incorrect water supply metering valve setting.
 - Neat polymer pump does not turn off or on correctly.
 - Piping to polymer mix chamber is plugged.
 - Neat polymer drum empty.
 - Neat polymer pump not operating properly.
 - Incorrect neat polymer metering pump setting.

5. Suspended solids in effluent.
 - Plates at fouled.
 - High level of sludge in sludge settling tank.
 - Influent flowrate too high.
 - Poor flocculation
 - pH not at target point.

5.8.1 High pH

Narrowing the Problem

1. Check pH in ME-4 (near the pH sensor) with a portable pH sensor or pH paper.
2. Clean and calibrate the pH sensor (CE-102).
3. Determine whether caustic is being pumped by observing the caustic pipe at ME-4.
4. Confirm that caustic pump selector switches are in the “Auto” or “Off” positions.
5. Confirm that the mixer (ME-17) is working.
6. Confirm that the metering pump is set to receive a 4-20 mA signal from the PLC.
7. Check the set points for the 4-20 mA signal from the pH controller to the PLC.
8. Check the set points for the PID control loop.
9. Test the pH sensor’s automatic wash system.

Corrective Actions

1. If the pH measured with the portable pH sensor is greatly different than the pH reading by CE-102, then the CE-102 sensor is dirty, needs calibrating, or is not operating properly. Clean and recalibrate CE-102. If the pH reading by the cleaned sensor begins to match the portable pH sensor reading, then increase the frequency of maintenance for CE-102. If the pH still varies from the portable pH sensor, then CE-102 is potentially damaged and should be repaired or replaced. Increase the frequency of the pH sensor’s automatic wash system if the sensor repeatedly fouls due to residue or film.
2. If the caustic metering pump is set to “Manual” mode, reset them to “Auto” mode. Ensure that the caustic metering pumps stop and that the pH begins to drop to the target pH. If the caustic metering pumps do not stop pumping ensure that they are set to pumps based on the PLC signal and not at a constant rate.
3. If mixer is not working, ensure that the mixer (ME-17) is receiving electrical power and that there is flow through flowmeter FM-803. If the mixer is receiving electrical power and there is not flow in FM-803, then mixer ME-17 will be disabled by the PLC but will turn on when flow is detected through FM-803. If the mixer is receiving electrical power and there is flow in FM-803, but is not working, follow the troubleshooting procedures in the mixer manufacturer’s manual (Volume 9).
4. If the set points for the 4-20 mA signal from the pH controller to the PLC are not set correctly (4 mA = 0 S.U.; 20 mA = 14 S.U.), reset them correctly.

5. If the set points for the PID control loop are not set correctly then reset them using Table 4-1 as a guideline.

5.8.2 Low pH

Narrowing the Problem

1. Check pH in ME-4 (near the pH sensor) with a portable pH sensor or pH paper.
2. Confirm that there is sufficient caustic in the storage tank (T-8).
3. Clean and calibrate the pH sensor.
4. Determine whether caustic is being pumped by observing the caustic pipe at ME-4.
5. Confirm that the caustic metering pump selector switches are in the "Manual" or "Auto" positions.
6. Confirm that all of the metering pump is set to receive a 4-20 mA signal from the PLC.
7. Confirm that the mixer (ME-17) is working.
8. Check the set points for the 4-20 mA signal from the pH controller to the PLC.
9. Check the set points for the PID control loop.
10. Test the pH sensor's automatic wash system.

Corrective Actions

1. If the pH measured with the portable pH sensor is greatly different than the pH reading by CE-102, then either the CE-102 sensor is dirty, needs calibrating, or is not operating properly. Clean and recalibrate CE-102. If the pH reading by the cleaned sensor begins to match the portable pH sensor reading, then increase the frequency of maintenance for CE-102. If the pH still varies from the portable pH sensor, then CE-102 is potentially damaged and should be repaired or replaced. Increase the frequency of the pH sensor's automatic wash system if the sensor repeatedly fouls due to residue or film.
2. If the caustic level in T-8 is low and/or the low level alarm in T-8 (LAL-8) is activated, order more caustic.
3. If caustic is not being pumped and the pH in ME-4 is below the target level, then insure that the caustic metering pump is in either "Auto" or "Manual" mode and that the caustic supply piping is not plugged or leaking, does not contain air blocks, and all of the valves are open. If caustic is still not being pumped, the caustic

metering pump may be damaged. Follow the troubleshooting procedures in the metering pump manufacturer's manual (Volume 9).

4. If the caustic metering pump is in "Auto" mode, caustic is being pumped, and the pH is still below the set point, then pumping stroke on the caustic metering pump needs to be increased. Ensure that the pH begins to rise to the target level.
5. If mixer is not working, ensure that the mixer (ME-17) is receiving electrical power. If the mixer is receiving electrical power but is not working, follow the troubleshooting procedures in the mixer manufacturer's manual (Volume 9).
6. If the set points for the 4-20 mA signal from the pH controller to the PLC are not set correctly (4 mA = 0 S.U.; 20 mA = 14 S.U.), reset them correctly.
7. If the set points for the PID control loop are not set correctly then reset them using Table 4-1 as a guideline.

5.8.3 Poor Flocculation

Narrowing the Problem

1. Confirm that the pH is correct in the flash mix tank (ME-4).
2. Determine whether the chemical composition of the process water has changed by checking the process monitoring logs
3. Determine whether the potable water supply is uninterrupted.

Corrective Actions

1. If the pH is correct, the composition of the process water has not changed, and polymer is being added to the flocculation tank, then the polymer dosage may be incorrect. Poor flocculation will occur if the dose of polymer is either too high or too low. Incorrect polymer dose can be the result of incorrect polymer pumping rate or incorrect polymer concentration.
2. Observe the polymer solution mixing chamber to determine whether the system is operating correctly.
3. Try increasing the polymer pumping rate. If that does not improve flocculation, try decreasing the pumping rate.
4. Determine if the polymer blending system has the appropriate ratio between concentrated polymer to potable water supply. Adjust either supply accordingly.
5. If the pH in ME-4 is not close to the target point, then correct the situation in accordance with either Section 5.8.1 or 5.8.2 above.

6. If inadequate flocculation persists after all recommended troubleshooting procedures have been tested, then call current polymer supplier to schedule a polymer jar test at the site. This jar test will determine whether a different polymer is required.

5.8.4 Polymer Blending System

Narrowing the Problem

1. Confirm that the polymer blending system is receiving power.
2. Confirm that the supply water pressure is less than 100 psi and confirm that there is sufficient dilution water flow through the polymer blending units, but not too much dilution water flow.
3. Confirm that the neat polymer feed line has a flooded suction.

Corrective Actions

If polymer is not being pumped to the flocculation tank, then confirm that the polymer feed tank is not empty and that the polymer feed pump selector switches are in the "Auto" positions. If the polymer feed pump selector switches are in the "Auto" positions, then temporarily turn the selector switch to "Manual" and manually pump the polymer to determine whether the pumping system is operating properly and that polymer is being pumped at the correct rate.

1. If the polymer is being pumped only in the "Manual" mode, then the control panel on the polymer blending unit is not functioning properly.
2. If the polymer is not being pumped while in the "Manual" mode, then the pumping system is not operating properly. Proceed as follows:
 - Confirm that the polymer pump turns on in the "Manual" mode.
 - Confirm that the polymer piping and tubing are not plugged and that the valves are open.
 - Confirm that the polymer suction piping and tubing are not loose at connections or cracked.
 - To increase the polymer concentration, increase the neat polymer pumping rate or operating time and/or adjust the water supply metering valve to dispense less water.
 - To decrease the polymer concentration, decrease the polymer pump pumping rate or operating time.

- Follow the troubleshooting procedures in the polymer blending system manufacturer's manual (Volume 9).

5.8.5 Suspended Solids in the Effluent

Narrowing the Problem

1. Measure the pH in the lamella effluent with a portable pH meter or pH paper and check pH in the rapid mix tank (ME-4) to confirm that the pH is close to the target (approximately 8.5 S.U.).
2. Observe floc in the middle of the lamella clarifier. Look for floc size and concentration and for floating floc.
3. Confirm that the influent flowrate as measured by flowmeter FM-803 is less than 60 gpm.
4. Open each of the decant ports in the lamella clarifier sludge holding tank individually to determine sludge level.
5. Inspect clarifier plates for solids buildup.
6. Confirm that the pump P-13 selector switches are in the "Hand" or "Auto" positions. If the pump is not in "Hand" position, turn pump on to confirm that the pump operates. If the pump does not operate in the "Hand" position, check if the air compressor (ME-24) is operating and that the solenoid valve to P-13 is open. If the air compressor is working and the solenoid valve is open, then follow the trouble shooting guide in the pump manufacturer's manual (Volume 9).

Corrective Actions

1. If the pH is above the target level then proceed in accordance with Section 5.8.1 (the section for high pH at the chemical precipitation unit). If the pH is below the target level then proceed in accordance with Section 5.8.2 (the section for low pH at the chemical precipitation unit). If the pH is out of the alarm range and the alarm was not activated (LAH-102 or LAL-102) was not activated, contact an electrician to determine why the PLC did not relay the alarm status.
2. If the floc is weak, small, floating or generally poor then proceed in accordance with Section 5.8.3 (the section for poor flocculation).
3. If there is no floc, then proceed in accordance with Section 5.8.4 (the section for polymer blending unit problems).
4. If the flowrate is greater than 60 gpm then decrease the system flowrate.
5. If the sludge level in the holding tank is high and the sludge pump operates, then increase the pumping frequency or duration of pump P-13 at the MMI.

6. If there are suspended solids on the plates, and the sludge pump operates, manually pump down the clarifier, clean the plates, and confirm that the sludge rake operates when there is flow through flowmeter FM-803. Repair the sludge rake if necessary. Increase pumping frequency or duration of the sludge pump and operate as normal.
7. If pump P-13 will not operate, then the pump needs repair, the air supply system (air compressor ME-24 and solenoid valve), or the PLC is preventing the pump from operating. First check the air supply system. Second confirm that the pump is not damaged or that the gaskets are worn and leaking air. If needed, contact an electrician to confirm whether the PLC is preventing the pump from operating.
8. If the valves are open and pump P-13 works in "Hand" mode but not in "Auto" mode, the timer in the PLC is not operating correctly. Reset the timer at the MMI. If resetting the timer switch does not work, contact an electrician to confirm whether the PLC is preventing the pump from operating.

5.9 HOLDING TANK T-2

Tank T-2 is a holding/pumping tank for pumping to the activated sludge plant (ME-101). Groundwater enters T-2 from the lamella clarifier (ME-6) and is pumped from T-2 to the activated sludge plant by pumps (P-3, P-4, and P-5). These pumps are controlled primarily by a level controller (LE-2) in the tank but can be automatically shut off if any one of many conditions set in the PLC are not met.

The holding tank might not operate properly for the following reasons:

1. Tank overflows or high level alarm sounds.
 - Level controller (LE-2) is not working properly.
 - PLC malfunctions.
2. Water is not being pumped out of T-2.
 - Valves are closed.
 - Level controller (LE-2) is not working properly.
 - Piping is plugged.
 - Pumps are off or not operating.
 - Sludge has built up in the tank.
 - PLC malfunctions.
 - The target water level in T-2 is set to high.

5.9.1 Tank Overflows or High Level Alarm Sounds

Narrowing the Problem

1. If water is overflowing T-2 and the alarm is not on, determine whether the tank level reading is correct.

2. If the high level alarm (LAH-2) is on, determine if the field pumps are still pumping (even though the tank level is high).

Corrective Actions

1. If the tank is overflowing, the alarm is not on, and the tank level reading is incorrect, then disable the field pumps, P-104, and P-105 and repair or replace the pressure transducer following the level controller manufacturer's manual (Volume 5).
2. If the tank is overflowing, the alarm is not on and the tank level reading is correct, then the PLC is not relaying the alarm status. Manually disable the field pumps, P-104, and P-105 and contact an electrician to determine why the PLC is not operating properly.
3. If the tank is overflowing, the alarm is on, and the tank level reading is correct, then the control panel is not relaying the disable signal to the field pumps. Manually disable the field pumps, P-104, and P-105 and contact an electrician to determine why the PLC is not operating properly.

5.9.2 Water is Not Being Pumped from the Tank

Narrowing the Problem

1. Determine whether that the tank level reading is correct.
2. Confirm that the water level in the tank is above the "pump on" level.
3. Confirm that the T-2 effluent valves are open.
4. Confirm that the pump(s) selector switches are in the "Hand" or "Auto" positions. If the pumps are not in the "Hand" position, turn them to "Hand" and confirm that they operate.
5. Confirm that no process alarms are activated.
6. Confirm that the target water level entered at the MMI (LT1-2) is the desired target level. Set to desired water level, if necessary.

If there is sufficient groundwater in the tank for the level controller (LE-2) to activate P-3, P-4, or P-5 and the selector switches for the pumps are in the "Hand" or "Auto" positions, then proceed as follows:

Corrective Actions

1. Determine whether activate P-3, P-4, or P-5 are operating.
2. If the pump(s) are operating then either the pump(s), pump effluent check valve, or piping is plugged, then the pump(s) needs to be repaired or the flowrate setting is

too low. If an adjacent check valve is not working, the discharge of one pump can backfeed through another pump.

3. If the pump is not operating and no process alarms are activated, then the pump(s) need repair or the PLC is preventing the pump(s) from operating. Follow the trouble shooting procedures in the pump manufacture's manual (Located in Volume 9 of this manual) and contact an electrician to confirm whether the PLC is preventing the pump from operating, if pump is found to be operating correctly.
4. If the pump is not operating and one or more alarms are activated, then determine the source of the alarm and proceed in accordance with the appropriate section of this manual.

If there is insufficient groundwater in the tank but the pump(s) continue to run, then proceed as follows:

Corrective Actions

1. Confirm that the influent pumps are in "Auto" mode. If the pumps are in "Hand" mode, turn the selector switch to "Auto" mode.
2. Determine whether the tank level reading is correct.
3. If the tank level reading is incorrect, then disable the pumps (P-3, P-4, and P-5) and re-calibrate or replace the level transducer following the level controller manufacturer's manual (Volume 5).
4. If the tank level reading is correct, then confirm that the tank has not become partially filled with sludge. Sludge buildup will result in incorrect reading by the pressure/level transducer. Collected sludge should be removed.
5. If the level control reading is correct and the tank has not accumulated sludge, then the PLC is not operating properly. Contact an electrician to determine why the PLC is not operating properly.

5.10 ACTIVATED SLUDGE PLANT (ME-101)

This section addresses troubled shooting procedures for the mechanical components of the activated sludge plant that are specific to the Smith & Loveless unit at the site.

Potential mechanical problems include:

1. High water level in ME-101.
 - Effluent piping is plugged.
 - Effluent valve(s) are closed.
 - Excessive air flow to the unit.

2. High torque on clarifier rake/skimmer.
 - Excessive sludge blanket.
 - Tool or other item blocking rake/skimmer movement.
 - Drive system obstructed.
 - Excessive material floating on clarifier surface.
3. No/low air flow.
 - Air valves closed.
 - Diffusers plugged.
 - Air lift(s) plugged.
 - Blower shutdown.
4. Solids in effluent.
 - Clarifier weir not level.
 - Biomass concentration too high.
 - Excessive material floating on clarifier surface.
 - Biomass is not settling.
 - RAS airlift not operating.
5. Sludge transfer pump not operating.
 - Closed valve.
 - Plugged piping.
 - Sludge pump P-102 damaged.
 - Sludge pump P-102 not operating frequently enough.
 - PLC malfunctioning.
 - Heater not operating/pump frozen.
6. Air lift pump(s) not operating.
 - Air lift pump clogged.
 - Not enough air.
 - Solenoid valve(s) closed.
 - Manual valve(s) closed.
 - PLC malfunctioning.

5.10.1 High Water Level in ME-101

Narrowing the Problem

1. Confirm that the manual valves in the pipe to the sand filter (ME-7) are open.
2. Confirm that there are no obstructions in the effluent weir box.
3. Check if high level alarm LAH-M101 is activated.
4. Check if the turbidity at DM-101 is high and if solenoid valves SV-101A and SV-101B are open or closed.
5. Check if the ME-101 air distribution valves are open wider than usual.

Corrective Actions

1. If ME-101 is overflowing and the flow through the effluent weir box is obstructed, then remove obstruction.
2. If ME-101 is overflowing and one of the effluent valves are closed, then open the valve.
3. If the effluent turbidity is high and both SV-101A and SV-101B are closed, then inspect SV-101B for damage. Replace the valve or motor if necessary. If the replacement valve/motor does not operate correctly, then contact an electrician to determine why the signal is not being transferred from the PLC to the valve.
4. If the effluent turbidity is not high but both SV-101A and SV-101B are closed, then inspect SV-101A for damage. Replace the valve or motor if necessary. If the replacement valve/motor does not operate correctly, then contact an electrician to determine why the signal is not being transferred from the PLC to the valve.
5. If the water level is high in ME-101, the turbidity is below the target level, and all of the effluent valves are open, then the piping may be plugged. Flush then interior of the pipes with clean water to remove blockage.
6. If the water level is high in ME-101, the turbidity is below the target level, and all of the effluent valves are open, and the effluent piping is not plugged, then the diffused air may be "lifting" the water level. If excess air is being applied to a particular zone, then slowly lower the air until the dissolved oxygen is around 4 mg/L.
7. If ME-101 is overflowing but the high level alarm (LAH-M101) has not been activated, then disable the process and field pumps and lower water level in ME-101 and clean the level switch (LSH-M101). If the level switch still does not operate, then the level switch may be damaged and may need to be replaced.

5.10.2 High Torque on Clarifier Rake/Skimmer

Narrowing the Problem

1. Inspect the motor drive belt for interference.
2. Inspect the skimmer arm for obstructions.
3. Inspect the clarifier surface for floating debris (leaves, dead sludge, etc.)
4. Inspect sludge total suspended solids data for recent irregularities.
5. Inspect the return activated sludge (RAS) stream for high solids concentration.
6. Check operation of the return activated sludge (RAS) airlift.

Corrective Actions

1. If there is interference in the motor drive belt, then shutoff and lockout the motor and remove obstruction. If additional motor maintenance is required, then perform

maintenance in accordance with the Smith & Loveless owner's manual (a copy is located in Volume 10 of this manual).

2. If there is an obstruction in the skimmer arm path, then shutoff and lockout the motor and remove obstruction.
3. If leaves or large materials are present on the clarifier surface, then manually skim the surface and collect the material. Larger material may not be able to be collected in the scum removal airlift.
4. If small items (including floating sludge) are present, then manually activate the scum removal airlift until the material is transferred. If the airlift does not operate, then follow the procedures in Section 5.10.6 below.
5. If the RAS airlift is not operating, then manually activate the airlift. If the airlift does not operate, then follow the procedures in Section 5.10.6 below.
6. If the RAS airlift is operating and the RAS has a lot of solids, then increase the RAS flowrate to decrease the sludge blanket in the clarifier. Consider increasing the RAS pumping rate. Collect follow-up samples to determine if sludge needs to be wasted.
7. If there is not visible obstruction and the sludge blanket is not excessively thick, then there may be a subsurface obstruction. Close the influent to the clarifier and activate the WAS airlift to pump the clarifier down. Inspect and repair the sludge rake as necessary utilizing appropriate confined space entry procedures.

5.10.3 No/Low Air Flow

Narrowing the Problem

1. Determine if the appropriate blower(s) is operating.
2. Determine if the low air flow alarm is activated.
3. Determine if the diffusers are plugged.
4. Determine if the air valve(s) are closed.
5. Determine if the air lift pumps are or can operate.

Corrective Actions

1. Determine if blowers ME-102, ME-103, and ME-104 are operating.
2. If the low air pressure alarm (PAL-102) has been activated, follow the troubleshooting procedures in the blower manufacturer's owners manual (Volume 9) to determine why the blowers are not operating.
3. If the blowers are not operating and the low air pressure alarm has not been activated, then determine if the low air pressure switch (PS-102) is damaged. If the switch is damaged, then replace it and follow the troubleshooting procedures in the

blower manufacturer's owners manual to determine why the blower is not operating. If the switch is not damaged, then contact an electrician to determine why the PLC is not relaying the alarm status correctly and follow the troubleshooting procedures in the blower manufacturer's owners manual (Volume 9) to determine why the blower is not operating.

4. If the blowers are operating but insufficient diffused air is reaching the tank, check the blower discharge line to determine whether there are any leaks at welds, bends, etc. If there is an air leak, shut blower down and repair the leak. If there is no air leak, the diffusers are plugged. Drain the tank and either clean or replace the diffusers.
5. If the demister is plugged, high air pressure in T-102 will shut down blower ME-105. If the demister is plugged, clean or replace the demister filter media and restart the system.

5.10.4 Solids in Effluent

Narrowing the Problem

1. Inspect the clarifier effluent weir to determine if the water is overflowing the "V" notches evenly.
2. Determine the sludge level in the tank.
3. Inspect the clarifier surface for floating debris.
4. Inspect the clarifier scum removal arm to ensure that it is moving.
5. Review recent analytical data to determine if the biomass concentration is increasing higher than usual. If no recent data is available, then collect sample from the reaction tank in a graduated cylinder and allow the biomass to settle. Record sludge quantity that settled.
6. Collect sample from the reaction tank in a graduated cylinder and allow the biomass to settle. Record sludge quantity that settled over standard duration of time. (The test should be conducted in accordance with the Smith & Loveless Owner's Manual located in Volume 10 of this manual.)
7. Inspect the scum removal airlift solenoid valve and timer (timer is located on the MMI).
8. Inspect the RAS weir box to ensure that the RAS airlift pump is operating.

Corrective Actions

1. If water is flowing unevenly over the "V" notches in the clarifier effluent weir, then the weir needs to be re-leveled. To re-level the weir, follow the procedures outlined

in the Smith & Loveless Owner's Manual located in Volume 10 of this manual. Be sure to follow proper confined space entry and tie-off procedures. If solids still overflow the re-leveled weir, then either there is too much biomass in the system or the scum removal system is not operating correctly. Proceed accordingly.

2. If the RAS airlift is not operating, then ensure that the solenoid valve and manual valve are open and that the timer is set for the RAS airlift to operate. If the RAS airlift does not operate, then biomass may buildup in the clarifier and overflow the weir. If the airlift valves are closed, then open them. If the timer is set incorrectly, then reset the timer to open the solenoid valve and allow the RAS airlift to operate. If the valves are open and the timer is activated, then the airlift may be plugged with biomass. To correct this problem, open the manual air valve wider to increase airflow to the airlift. Once the airlift begins pumping RAS, then close to a location that is slightly more than the valves were previously set. Continue this process until the airlift does not continually plug.
3. Increase RAS removal rates if the sludge level is high.
4. If the floating solids do not appear to be biomass and the scum removal arm is not moving, then check the shear pin for the scum removal arm/sludge rake. If the pin is broken, then replace the pin. If the pin is not broken, then ensure that the motor is receiving electrical power. Contact electrician and restore electrical power if necessary.
5. If the floating solids do not appear to be biomass and the scum removal arm is moving, then increase the frequency or duration of operation for the scum removal airlift.
6. If the historical data or sludge settling test indicate that the biomass concentration is greater than desired, then notify Engineer and develop biomass wasting plan.

5.10.5 Sludge Transfer Pump not Operating

Narrowing the Problem

1. Confirm that the valves in the pipe to the organic sludge holding tank (T-104) are open.
2. Confirm that the pump P-102 selector switches are in the "Hand" or "Auto" positions. If the pump is not in "Hand" position, turn pump to "Hand" to confirm that the pump operates. If the pump does not operate in the "Hand" position, check if the air compressor (ME-24) is operating and that the solenoid valve to P-102 is open. If the air compressor is working and the solenoid valve is open, then follow the trouble shooting guide in the pump manufacturer's manual (Volume 9).
3. Confirm that the timer in the MMI/PLC is set correctly.

4. Confirm that suspended solids are not built up to the extent that excessive suspended solids are overflowing the clarifier's effluent weir.
5. During winter, confirm that the piping heat trace and pump heater are operating.

Corrective Actions

1. If suspended solids are building up, the valves are open, and pump P-102 will operate, then the pipe to the sludge holding sections of the activated sludge plant should be cleaned to eliminate any plugging.
2. If suspended solids are building up, valves are open, and pump P-102 will not operate, then the pump needs repair, the air supply system (air compressor ME-24 and solenoid valve), or the PLC is preventing the pump from operating. First check the air supply system. Second confirm that the pump is not damaged or that the diaphragms are worn and leaking air. If needed, contact an electrician to confirm whether the PLC is preventing the pump from operating.
3. If the valves are open and pump P-101 works in "Hand" mode but not in "Auto" mode, the timer in the PLC is not operating correctly. Reset the timer to pump for a short duration and monitor if the pump pumps. If resetting the timer does not work, contact an electrician to confirm whether the PLC is preventing the pump from operating.
4. If it is winter and heat trace or pump heater are not working, then repair or replace damaged equipment. Note that this may require an electrician.

5.10.6 Air Lift Pump(s) not Operating

The activated sludge plant contains four internal airlift pumps controlled by solenoid valves. The airlift pumps are used to transfer (1) RAS to the reaction zone, (2) WAS to the first digester zone, (3) scum from the clarifier surface to the first digester zone, and (4) digested sludge from the first digester zone to the second digester zone. If one of these air lift pumps does not operate correctly then proceed as indicated below:

Narrowing the Problem

1. Confirm that the air solenoid valve(s) for the airlift(s) is open.
2. Confirm that the manual air valve(s) for the airlift(s) is open.
3. Confirm that the PLC/MMI is set correctly to open the solenoid valve.
4. Confirm that the blower(s) for the activated sludge plant is operating.
5. Confirm that the air source for the lifts is working properly.

Corrective Actions

1. If one or more of the manual valves for the airlift air supply line are closed, then open them and wait for the airlift to begin pumping. If the airlift does not operate after approximately 15 minutes, then the piping may be plugged. To unplug the piping, temporarily increase the airflow to the airlift by either opening the manual

valves more or decreasing the air to one of the digesters. Once the airlift begins to pump, then return the airflow to the airlift to normal.

2. If the airlift is turned off at the PLC (either manually or by timer) then reset the operation at the MMI. The airlift should operate correctly. If the airlift does not operate after approximately 15 minutes, then the piping may be plugged. To unplug the piping, temporarily increase the airflow to the airlift by either opening the manual valves more or decreasing the air to one of the digesters. Once the airlift begins to pump, then return the airflow to the airlift to normal.
3. If the blower(s) is not operating, then follow the trouble shooting procedures for the blowers outlined in the Smith & Loveless Owner's Manual.

5.11 SAND FILTER (ME-7)

The purpose of the sand filter is to remove the suspended solids remaining in the activated sludge plant effluent. Groundwater flows by gravity to and from the sand filter. The suspended solids are removed from the groundwater by filtration through sand. The sand is continuously backwashed to keep the sand clean. The backwash water is air lifted to the sand filter backwash water holding tank (T-105). The backwash water is either pumped to the lamella clarifier or flows by gravity to tank T-2.

For all problems associated with the sand filter, see the manufacturer's operation and maintenance manual located in Volume 7 of this manual.

Some common problems are outlined below:

1. Low flow through unit.
 - Effluent valves partially closed.
 - Excessive headloss through unit.
 - Solenoid valve SV-101A partially closed.
2. High head loss (> 10 psi).
 - Excessive solids in influent.
 - Growth and accumulation of microorganisms on filter media.
 - Dirty filter.
3. Poor effluent quality.
 - Flow surges through plant.
 - Dirty Filter.
 - Poor influent quality.
4. No backwash flowrate.
 - Backwash airlift failure.

5.11.1 Low Flow through Unit

Narrowing the Problem

1. Confirm that the influent and effluent valves are completely open.
2. Monitor headloss level on gauge.
3. Confirm that the turbidity level measured by turbidity meter DM-101 is below the maximum level set at the MMI.

Corrective Actions

1. If either the influent or effluent valves are closed or partially closed, then completely open them.
2. If the manual influent and effluent valves are open, the headloss is less than 10 psi, and the turbidity level at DM-101 is below the target point, then solenoid valve SV-101A is either not operating properly or not receiving a signal from the PLC. Follow the trouble shooting section of the solenoid valve manufacturers owner's manual to determine if the valve is broken or functioning incorrectly (Volume 9 of this manual). If the solenoid valve is not damaged, then contact an electrician to determine why the PLC is relaying a false alarm status.
3. If the manual influent and effluent valves are open, the headloss is less than 15 psi, and the turbidity level at DM-101 is above the target point, then solenoid valve SV-101A and SV-101B are correctly recycling the water back to tank T-2 for retreatment. The system is operating correctly.
4. If the manual influent and effluent valves are open, the turbidity level at DM-101 is below the target point, and the headloss is greater than 10 psi, then increase the backwash flowrate to clean the filter media.

5.11.2 High Head Loss (> 10 psi)

Narrowing the Problem

1. Confirm that the turbidity level measured by DM-101 is below the set point.
2. Determine if the high turbidity alarm (DAH-101) is activated.
3. Visually inspect the sand filter influent for suspended solids.
4. Confirm that backwash water is being discharged to the sand filter backwash water holding tank (T-105).

Corrective Actions

1. If backwash is not discharging to tank T-105, then make sure all of the valves are open in the discharge pipe and that the pipe is not plugged. Clean pipe to remove plugging if necessary.
2. If the turbidity level at DM-101 is below the set point, there is no visual evidence of solids in the influent, and the head loss is greater than 10 psi, then increase the backwash rate. If the head loss does not decrease, then the filter media is either clogged or microorganisms have accumulated and needs to be replaced.

If microorganisms have accumulated, then check chemical feed systems for operational problems.

3. If the turbidity level at DM-101 is below the set point but there is visual evidence of solids in the influent and the head loss is greater than 10 psi, then clean and recalibrate DM-101. If the turbidity reading does not change, then the maximum turbidity level for DM-101 needs to be lowered at the MMI.
4. If the turbidity level at DM-101 is above the set point, high turbidity alarm (DAH-101) is activated, there is visual evidence of solids in the influent, and the head loss is greater than 10 psi, then solenoid valve SV-101A is either not operating properly or not receiving a signal from the PLC. Follow the trouble shooting section of the solenoid valve manufacturers owner's manual to determine if the valve is broken or functioning incorrectly (Volume 9 of this manual). If the solenoid valve is not damaged, then contact an electrician to determine why the PLC is not relaying the alarm status (DAH-101) correctly.
5. If the turbidity level at DM-101 is above the set point, high turbidity alarm (DAH-101) is not activated, there is visual evidence of solids in the influent, and the head loss is greater than 10 psi, then the PLC is not correctly processing the alarm. Contact an electrician to determine why the PLC is not relaying the alarm status (DAH-101) correctly.

5.11.3 Poor Effluent Quality

Narrowing the Problem

1. Confirm that the turbidity level measured by DM-101 is below the set point.
2. Determine if the high turbidity alarm (DAH-101) is activated.
3. Review DAH-101 alarm history at the MMI.
4. Visually inspect the sand filter influent for suspended solids.
5. Monitor the activated sludge plant effluent for suspended solids

Corrective Actions

1. If the turbidity level at DM-101 is below the set point but there is visual evidence of solids in the influent, then clean and recalibrate DM-101. If the turbidity reading does not change, then the maximum turbidity level for DM-101 needs to be lowered at the MMI.
2. If the turbidity level at DM-101 is above the set point, high turbidity alarm (DAH-101) is activated, and there is visual evidence of solids in the influent, then solenoid valve SV-101A is either not operating properly or not receiving a signal from the PLC. Follow the trouble shooting section of the solenoid valve manufacturers owner's manual to determine if the valve is broken or functioning incorrectly (Volume 9 of this manual). If the solenoid valve is not damaged, then contact an electrician to determine why the PLC is not relaying the alarm status (DAH-101) correctly.

3. If the turbidity level at DM-101 is above the set point, high turbidity alarm (DAH-1-1) is not activated, and there is visual evidence of solids in the influent, then the PLC is not correctly processing the alarm. Contact an electrician to determine why the PLC is not relaying the alarm status (DAH-101) correctly.
4. If the turbidity level at DM-101 is below the set point and there is no visual evidence of solids in the influent but the sand filter effluent contains suspended solids, then the backwash rate needs to be increased.
5. If the turbidity level at DM-101 is below the set point and there is visual evidence of solids in the influent but the sand filter effluent contains suspended solids, then the maximum turbidity level at DM-101 needs to be decreased at the PLC.
6. If high turbidity alarm DAH-101 has been activated frequently then the influent to the sand filter has been erratic because solenoid valves SV-101A and SV-101B recycle the process water during this alarm. This causes surges through the sand filter and reduces effluent quality and is an indication of problems with the activated sludge plant. Refer to the activated sludge plant operations and maintenance manual located in Volume 9 of this manual to correct the problem.

5.11.4 No Backwash Flowrate

Defining the Problem

1. Confirm that the valves for backwash discharge to tank T-105 are open.
2. Confirm that the airlift pump for the backwash water is receiving air from the air compressor ME-24.

Corrective Actions

1. If the airlift pump is operating, and the valves to tank T-105 are open, but there is no backwash being discharged, then clean the pipe to tank T-105 may be plugged.
2. If the airlift pump is not operating, check air supply and restart pump.
3. If air is being supplied to the air lift pump, the discharge pipe is not plugged, and the valves are open, then manually restart the pump by manually activating the level switch for a few seconds. The airlift pump should restart.

5.12 HOLDING TANK T-3

Tank T-3 is a holding/pumping tank for pumping the GWTP effluent. Groundwater enters T-3 from the sand filter (ME-7) effluent and is pumped through the effluent pH adjustment system and to the wetlands by pumps (P-6, P-7, and P-8). These pumps are controlled primarily by a level controller (LE-3) in the tank.

The equalization tank might not operate properly for the following reasons:

1. Tank overflows or high level alarm sounds.
 - Level controller (LE-3) is not working properly.
 - PLC malfunctions.
2. Water is not being pumped out of T-3.
 - Valves are closed.
 - Level controller (LE-3) is not working properly.
 - Piping is plugged.
 - Pumps are off or not operating.
 - Sludge has built up in the tank.
 - PLC malfunctions.
 - Target water level (LT1-3) is set to low.
 - Excessive solids buildup in sand filter beds (ME-8 and ME-9) or GAC units (ME-33 and ME-34).
3. High pH
 - Influent process water pH is excessively high.
 - The sulfuric acid metering pump selector switches are set to “Off” position.
 - Sulfuric acid pumping stroke setting is too low.
 - Sulfuric acid pumping system is not functioning properly, possibly due to:
 - Plugged piping
 - A Broken pump
 - A Closed valve
 - Leaking caustic suction tubing
 - Sulfuric acid supply is low.
 - pH controller is not operating properly.
 - Mixer is not operating.
 - pH sensor is dirty or needs calibration.
 - The 4-20 mA signals are set incorrectly at the PLC/MMI.
4. Low pH
 - Sulfuric acid metering pump selector switches are set to “Manual” position.
 - Sulfuric acid metering pump touch pad has been set to pump at a constant rate rather than accept a 4-20 mA signal from the PLC.
 - Mixer is not operating.
 - pH sensor is dirty or needs calibration.
 - pH controller is not operating properly.
 - The 4-20 mA signals are set incorrectly at the PLC/MMI.

5.12.1 Tank Overflows or High Level Alarm Sounds

Narrowing the Problem

1. If water is overflowing T-3 and the alarm is not on, determine whether the tank level reading is correct.

2. If the high level alarm (LAH-3) is on, determine if the field pumps, P-3, P-4, P-5, P-9, P-10, P-104 or P-105 are still pumping (even though the tank level is high).

Corrective Actions

1. If the tank is overflowing, the alarm is not on, and the tank level reading is incorrect, then disable the field pumps, P-3, P-4, P-5, P-9, P-10, P-104, and P-105 and check the set points for the 4-20 mA signal from the level controller to the PLC. If the set points do not match the set points in Table 4-1, set them to match Table 4-1. If the set points match Table 4-1, then repair or replace the pressure transducer following the level controller manufacturer's manual (Volume 5).
2. If the tank is overflowing, the alarm is not on and the tank level reading is correct, then the PLC is not relaying the alarm status. Disable the field pumps, P-3, P-4, P-5, P-9, P-10, P-104, and P-105 and contact an electrician to determine why the PLC is not operating properly.
3. If the tank is overflowing, the alarm is on, and the tank level reading is correct, then the control panel is not relaying the disable signal to the field pumps, P-3, P-4, P-5, P-9, P-10, P-104, and P-105. Manually disable the field pumps, P-3, P-4, P-5, P-9, P-10, P-104, and P-105 and contact an electrician to determine why the PLC is not operating properly.

5.12.2 Water is Not Being Pumped from the Tank

Narrowing the Problem

1. Determine whether that the tank level reading is correct and confirm that the set points for the 4-20 mA signal from the level sensor to the PLC match the set points in Table 4-1. Reset the set points if necessary.
2. Confirm that the water level in the tank is above the target water level (LT1-3).
3. Confirm that the T-3 effluent valves are open.
4. Confirm that the pump(s) selector switches are in the "Hand" or "Auto" positions. If the pumps are not in the "Hand" position, turn them to "Hand" and confirm that they operate.
5. Check the influent and effluent pressures of the sand filter beds (ME-8 and ME-9) and GAC units (ME-33 and ME-34).

If there is sufficient groundwater in the tank for the level controller (LE-3) to activate P-6, P-7, or P-8 and the selector switches for the pumps are in the "Hand" or "Auto" positions, then proceed as follows:

Corrective Actions

1. Determine whether activate P-6, P-7, or P-8 are operating.
2. If the influent pressure to ME-8 and ME-9 is significantly greater than the effluent pressure or it is greater than historic operating levels, then engage the automatic backwash system for the units. If the pressure differential does not drop, proceed in accordance with Section 5.14.
3. If the influent pressure to ME-33 and ME-34 is significantly greater than the effluent pressure or it is greater than historic operating levels, then proceed in accordance with Section 5.15.
4. If the pump(s) are operating then the pump(s), pump effluent check valves or piping, sand filter beds (ME-8 and ME-9), or GAC units (ME-33 and ME-34) are plugged, the pump(s) needs to be repaired, or the flowrate setting is too low. Disable and clean the pumps, check valve, and piping. If the pumps still do not pump then follow the trouble shooting procedures in the pump manufacturer's manual (Located in Volume 7 of this manual):
5. If the pump is not operating and no process alarms are activated, then the pump(s) need repair or the PLC is preventing the pump(s) from operating. Follow the trouble shooting procedures in the pump manufacture's manual (Located in Volume 7 of this manual) and contact an electrician to confirm whether the PLC is preventing the pump from operating.

If there is insufficient groundwater in the tank but the pump(s) continue to run, then proceed as follows:

Corrective Actions

1. Confirm that the influent pumps are in "Auto" mode. If the pumps are in "Hand" mode, turn the selector switch to "Auto" mode.
2. Determine whether the tank level reading is correct.
3. If the tank level reading is incorrect, then disable the pumps (P-6, P-7, and P-8) and re-calibrate or replace the level transducer following the level controller manufacturer's manual (Volume 5).
4. If the tank level reading is correct, then confirm that the tank has not become partially filled with sludge. Sludge accumulation will interfere with the water level readings and should be removed.
5. If the level control reading is correct and the tank has not accumulated sludge, then the PLC is not operating properly. Contact an electrician to determine why the PLC is not operating properly.

5.12.3 High pH

Narrowing the Problem

1. Check pH in T-3 (near the pH sensor) and T-3 influent with a portable pH sensor or pH paper.
2. Confirm that there is sulfuric acid in the sulfuric acid storage tank (T-9).
3. Clean and calibrate the pH sensor (CE-3).
4. Determine whether sulfuric acid is being pumped by observing the sulfuric acid pipe at the mixing tank.
5. Confirm that sulfuric acid pump selector switches are in the "Manual" or "Auto" positions.
6. Confirm that caustic pump selector switches are in the "Auto" or "Off" positions.
7. Confirm that the mixer (ME-20) is working.
8. Confirm that the metering pump is set to receive a 4-20 mA signal from the PLC.
9. Check the set points for the 4-20 mA signal from the pH controller to the PLC.
10. Check the set points for the PID control loop.
11. Test the pH sensor's automatic wash system.

Corrective Actions

1. If the pH measured with the portable pH sensor is greatly different than the pH reading by CE-3, then either the CE-3 sensor is dirty, needs calibrating, or is not operating properly. Clean and recalibrate CE-3. If the pH reading by the cleaned sensor begins to match the portable pH sensor reading, then increase the frequency of maintenance for CE-3. If the pH still varies from the portable pH sensor, then CE-3 is potentially damaged and should be repaired or replaced. Increase the frequency of the pH sensor's automatic wash system if the sensor repeatedly fouls due to residue or film.
2. If the sulfuric acid level in T-9 is low and/or the low level alarm in T-9 (LAL-9) is activated, order more acid.
3. If the set points for the 4-20 mA signal from the pH controller to the PLC are not set correctly (4 mA = 0 S.U.; 20 mA = 14 pH), reset them correctly.
4. If the set points for the PID control loop are not set correctly, then set them in accordance with Table 4-1.

5. If sulfuric acid is not being pumped and the pH in T-3 is above the target level, then insure that the sulfuric metering pumps are in either “Auto” or “Manual” mode and that the acid supply piping is not plugged or leaking, does not contain air blocks, and all of the valves are open. If sulfuric acid is still not being pumped, the sulfuric acid metering pump may be damaged. Follow the troubleshooting procedures in the metering pump manufacturer’s manual (Volume 9).
6. If the sulfuric acid metering pumps are in “Auto” mode, sulfuric acid is being pumped, and the pH is still above the set point, then the pumping stroke length on the sulfuric acid metering pumps needs to be increased. Ensure that the pH begins to drop to the target level.
7. If mixer is not working, ensure that the mixer (ME-20) is receiving electrical power. If the mixer is receiving electrical power but is not working, follow the troubleshooting procedures in the mixer manufacturer’s manual (Volume 9).

5.12.4 Low pH

Narrowing the Problem

1. Check pH in T-3 (near the pH sensor) and T-3 influent with a portable pH sensor or pH paper.
2. Confirm that there is sufficient sulfuric in the storage tank (T-8).
3. Clean and calibrate the pH sensor.
4. Determine whether caustic is being pumped by observing the caustic pipe at the mixing tank.
5. Determine whether sulfuric acid is being pumped by observing the sulfuric acid pipe at the mixing tank.
6. Confirm that the caustic metering pump selector switches are in the “Manual” or “Auto” positions.
7. Confirm that the sulfuric acid metering pump selector switches are in the “Auto” or “Off” positions.
8. Confirm that the metering pump is set to receive a 4-20 mA signal from the PLC.
9. Confirm that the mixer (ME-20) is working.
10. Check the set points for the 4-20 mA signal from the pH controller to the PLC.
11. Check the set points for the PID control loop.
12. Test the pH sensor’s automatic wash system.

Corrective Actions

1. If the pH measured with the portable pH sensor is greatly different than the pH reading by CE-3, then either the CE-3 sensor is dirty, needs calibrating, or is not operating properly. Clean and recalibrate CE-3. If the pH reading by the cleaned sensor begins to match the portable pH sensor reading, then increase the frequency of maintenance for CE-3. If the pH still varies from the portable pH sensor, then CE-3 is potentially damaged and should be repaired or replaced. Increase the frequency of the pH sensor's automatic wash system if the sensor repeatedly fouls due to residue or film.
2. If the caustic level in T-8 is low and/or the low level alarm in T-8 (LAL-8) is activated, order more caustic.
3. If the sulfuric acid metering pumps are set to "Manual" mode, reset them to "Auto" mode. Ensure that the sulfuric acid metering pumps stop and that the pH begins to rise to the target pH. If the sulfuric acid metering pump does not stop pumping ensure that they are set to pump based on the PLC signal and not at a constant rate.
4. If mixer is not working, ensure that the mixer (ME-20) is receiving electrical power. If the mixer is receiving electrical power but is not working, follow the troubleshooting procedures in the mixer manufacturer's manual (Volume 9).
5. If the set points for the 4-20 mA signal from the pH controller to the PLC are not set correctly (4 mA = 0 S.U.; 20 mA = 14 S.U.), reset them correctly.
6. If the set points for the PID control loop are set incorrectly, then set them using Table 4-1 as a guideline.

5.13 ULTRAVIOLET OXIDATION UNIT (ME-2)

For all problems associated with the ultraviolet oxidation unit, see the manufacturer's operation and maintenance manual located in Volume 8 of this manual.

5.14 SAND FILTER BEDS (ME-8 AND ME-9)

Two 1,500-lb sand filter beds (ME-8 and ME-9) are used as polishing units to remove residual levels of suspended solids and organic contaminants before discharge.

The sand filter beds might not operate properly for the following reasons:

1. Low flow.
 - Discharge valve partially closed.
 - Excessive head loss through units.
 - Valves in system positioned incorrectly.

2. High head loss (> 15 psi).
 - Poor influent water quality.
 - Growth and accumulation of biological solids in the beds.
 - Filter media deterioration during handling and large amounts of fines.
 - Distribution header plugged.
 - Automatic backwash system not operating correctly.
3. Poor effluent quality.
 - Filter media is saturated with contaminants as by evidence of high contaminant concentration in the lead unit (s).
 - Filter media fines in the effluent.
 - Contaminated filter media received from vendor.

5.14.1 Low Flow

Narrowing the Problem

1. Ensure that the influent and effluent valves are completely open.
2. Ensure that the valves in the header system are positioned correctly.
3. Review automatic backwash log at MMI.
4. Monitor the influent and effluent pressure for each unit (current pressures as well as historic trends).
5. Confirm that the backwashing routine is operating properly.

Corrective Actions

1. If the influent or effluent valves are closed or partially closed then open them completely.
2. If the header valves are not adjusted correctly, then adjust them to allow flow through the sand filter beds in the desired sequence.
3. If the influent and effluent valves are both completely open, the header valves are correctly adjusted, the units have been recently backwashed, and the influent pressure to a particular unit is significantly higher than the effluent pressure, then contact the filter media vendor or vessel supplier to inspect the suspect unit(s).
4. If the influent and effluent valves are both completely open, the header valves are correctly adjusted, and the units have not been recently backwashed, then engage the automatic backwash system.

5.14.2 High Head Loss (> 15 psi)

Narrowing the Problem

1. Inspect the sand filter for presence of suspended solids.
2. Confirm that the backwashing routine is operating properly.

3. Monitor the influent and effluent pressure of each vessel to determine if one particular vessel is causing the problem.
4. Ensure that the valves in the header are positioned correctly.
5. Review automatic backwash log at the MMI.
6. Check the operation of the solenoid valves associated with the automatic backwash system.

Corrective Actions

1. If one the solenoid valves for the automatic backwash system is damaged, replace the valve or valve motor as needed.
2. If there obvious suspended solids in the sand filter effluent conduct trouble shooting procedures in accordance with Section 5.11 of this manual and backwash the units to remove accumulated solids.
3. If there are no solids in the sand filter effluent, the header valves are positioned correctly, and the units have not recently been backwashed, then backwash the units.
4. If there are no solids in the sand filter effluent, the header valves are positioned correctly, and the units have recently been backwashed, then contact the filter media vendor or vessel supplier to inspect the suspect unit(s) with the high pressure loss.
5. If one unit has a significantly higher pressure differential than the other, then the header piping may be plugged. Reverse flow for 1 to 2 minutes to remove fines.

5.14.3 Poor Effluent Equality

Narrowing the Problem

1. Review filter media change-out logs.
2. Review GWTP process monitoring data.
3. Collect ME-8/ME-9 effluent sample.

Corrective Actions

1. If the time since the last filter media change out exceeds historic times, then change-out the filter media.
2. Confirm that the backwash is working properly.
3. If the GWTP process monitoring data indicates high contaminant concentration entering the sand filter beds and the time since the last filter media change out is approaching historic times, then change-out the filter media.

4. If the effluent sample contains fines, recycle effluent until fines are removed. If the fines do not washout quickly, then the filter media was received from the vendor with excessive fines. The filter media vendor should be contacted and the filter media replaced.
5. If the effluent quality is poor and the filter media has recently been changed, then the filter media was received from the vendor with contaminants. The filter media vendor should be contacted and the filter media replaced.

5.15 GRANULAR ACTIVATED CARBON (GAC) UNITS (ME-33 AND ME-34)

Two 10,000-lb GAC units (ME-33 and ME-34) are used as polishing units to remove residual levels of organic contaminants before discharge.

The GAC units might not operate properly for the following reasons:

1. Low flow.
 - Discharge valve partially closed.
 - Excessive head loss through units.
 - Valves in GAC header system positioned incorrectly.
2. High head loss (> 15 psi).
 - Poor influent water quality.
 - Growth and accumulation of biological solids in the contactor.
 - Carbon deterioration during handling and large amounts of carbon fines.
 - Distribution header plugged.
3. Poor effluent quality.
 - Carbon is exhausted as by evidence of high contaminant concentration in the lead unit (s).
 - Carbon fines in the effluent.
 - Contaminated carbon received from vendor.

5.15.1 Low Flow

Narrowing the Problem

1. Ensure that the influent and effluent valves are completely open.
2. Ensure that the valves in the GAC header are positioned correctly.
3. Review carbon change out log.
4. Monitor the influent and effluent pressure for each GAC unit.

Corrective Actions

1. If the influent or effluent valves are closed or partially closed then open them completely.

2. If the GAC header valves are not adjusted correctly, then adjust them to allow flow through the carbon units in the desired sequence.
3. If the influent and effluent valves are both completely open, the GAC header valves are correctly adjusted, the carbon has been recently backwashed, and the influent pressure to a particular GAC unit is significantly higher than the effluent pressure, then contact the GAC vendor to inspect the suspect unit(s).
4. If the influent and effluent valves are both completely open, the GAC header valves are correctly adjusted, and the carbon has not been recently replaced, then the carbon may need to be backwashed or replaced. Contact the carbon supplier.

5.15.2 High Head Loss (> 15 psi)

Narrowing the Problem

1. Inspect the sand filter for presence of suspended solids or the buildup of biological mass.
2. Monitor the influent and effluent pressure of each vessel to determine if one particular vessel is causing the problem.
3. Ensure that the valves in the GAC header are positioned correctly.
4. Review carbon changeout log.

Corrective Actions

1. If there obvious suspended solids in the sand filter effluent conduct trouble shooting procedures in accordance with Section 5.11 of this manual and contact the carbon supplier to either have the units backwashed or the carbon replaced.
2. If there are no solids in the sand filter effluent, the GAC header valves are positioned correctly, and the carbon has not recently been replaced, then the carbon may need to be backwashed or replaced. Contact the carbon supplier.
3. If there are no solids in the sand filter effluent, the GAC header valves are positioned correctly, and the carbon has recently been replaced, then contact the GAC vendor to inspect the suspect unit(s) with the high pressure loss.
4. If there is significant pressure loss between GAC units, then the GAC header piping may be plugged. Reverse flow for 1 to 2 minutes to remove fines.
5. If there is a buildup of biological mass, disinfect the tank T-3 by running a chlorine solution through the unit.

5.15.3 Poor Effluent Equality

Narrowing the Problem

1. Review carbon change-out logs.
2. Review GWTP process monitoring data.
3. Collect GAC effluent sample.

Corrective Actions

1. If the time since the last carbon change out exceeds historic times, then change-out the carbon.
2. If the GWTP process monitoring data indicates high contaminant concentration entering the GAC units and the time since the last carbon change out is approaching historic times, then change-out the carbon.
3. If the effluent sample contains carbon fines, recycle effluent until fines are removed. If the carbon fines do not washout quickly, then the carbon was received from the vendor with excessive fines. The carbon vendor should be contacted and the carbon replaced.
4. If the effluent quality is poor and the carbon has recently been changed, then the carbon was received from the vendor with contaminants. The carbon vendor should be contacted and the carbon replaced.

5.16 EFFLUENT PH ADJUSTMENT SYSTEM

Note: Tank T-3 provides final pH adjustment for the system and automatic recycle valves have been installed to recycle effluent which does not meet the pH discharge requirement. Therefore, the effluent pH adjustment system has been removed. The effluent is still monitored, however, for final pH.

The effluent pH adjustment system might not operate properly for the following reasons.

1. High pH
 - Influent process water to the effluent header system has an excessively high pH.
 - Caustic metering pump selector switches are set to "Manual" position.
 - Caustic metering pump touch pad has been set to pump at a constant rate rather than accept a 4-20 mA signal from the PLC.
 - The sulfuric acid metering pump selector switches are set to "Off" position.
 - Sulfuric acid pumping stroke setting is too low.
 - Sulfuric acid pumping system is not functioning properly.
 - Plugged piping
 - Broken pump
 - Closed valve
 - Leaking caustic suction tubing

- Sulfuric acid supply is low.
 - pH controller is not operating properly.
 - pH sensor is dirty or needs calibration.
 - Mixer is not operating.
 - The set points for the 4-20 mA signal from the pH analyzer to the PLC are not correct.
 - The set points for the PID control loop are correct.
2. Low pH
- Caustic supply level is low.
 - Caustic metering pump selector switches are in the “Off” position.
 - Caustic metering pumping stroke setting is too low.
 - Caustic pumping system is not functioning properly, possibly due to:
 - Plugged piping
 - A Broken pump
 - A Closed valve
 - Leaking caustic suction tubing
 - Sulfuric acid metering pump selector switches are set to “Manual” position.
 - Sulfuric acid metering pump touch pad has been set to pump at a constant rate rather than accept a 4-20 mA signal from the PLC.
 - Mixer is not operating.
 - pH sensor is dirty or needs calibration.
 - pH controller is not operating properly.
 - The set points for the 4-20 mA signal from the pH analyzer to the PLC are not correct.
 - The set points for the PID control loop are correct.
3. Recycle valves not working.
- Solenoid valve SV-110A is not operating.
 - Solenoid valve SV-110B is not operating.
 - Solenoid valves not receiving signal from PLC.

5.16.1 High pH

Narrowing the Problem

1. Check the effluent pH at the sample port with a portable pH sensor or pH paper.
2. Confirm that there is sulfuric acid in the sulfuric acid storage tank (T-9).
3. Clean and calibrate the pH sensor (CE-110).
4. Confirm that sulfuric acid pump selector switches are in the “Manual” or “Auto” positions.
5. Confirm that caustic pump selector switches are in the “Auto” or “Off” positions.

6. Confirm that the mixer (ME-110) is not damaged or that the mixing blades are not obstructed.
7. Confirm that all of the metering pumps are set to receive a 4-20 mA signal from the PLC.
8. Confirm that the set points for the 4-20 mA signal from the pH analyzer (CIC-110) to the PLC are correct (Table 4-1 can be used for reference).
9. Confirm that the set points for the PID control loop are correct (Table 4-1 can be used for reference).

Corrective Actions

1. If the pH measured with the portable pH sensor is greatly different than the pH reading by CE-110, then either the CE-110 sensor is dirty, needs calibrating, or is not operating properly. Clean and recalibrate CE-110. If the pH reading by the cleaned sensor begins to match the portable pH sensor reading, then increase the frequency of maintenance for CE-110. If the pH still varies from the portable pH sensor, then CE-110 is potentially damaged and should be repaired or replaced.
2. If the sulfuric acid level in T-9 is low and/or the low level alarm in T-9 (LAL-9) is activated, order more acid.
3. If the caustic metering pump are set to "Manual" mode, reset them to "Auto" mode. Ensure that the caustic metering pump stop and that the pH begins to drop to the target pH. If the caustic metering pump do not stop pumping, ensure that they are set to pumps based on the PLC signal and not at a constant rate.
4. If the set points for the 4-20 mA signal from the pH analyzer (CIC-110) to the PLC are incorrect (Table 4-1 can be used for reference), then set them to match the set points in Table 4-1.
5. If the set points for the PID control loop are incorrect (Table 4-1 can be used for reference), then set them to match the set points in Table 4-1.
6. If sulfuric acid is not being pumped and the pH in effluent is above the target level, then insure that the sulfuric metering pump is in either "Auto" or "Manual" mode and that the acid supply piping is not plugged or leaking, does not contain air blocks, and all of the valves are open. If sulfuric acid is still not being pumped, the sulfuric acid metering pump may be damaged. Follow the troubleshooting procedures in the metering pump manufacturer's manual (Volume 9).
7. If the sulfuric acid metering pump is in "Auto" mode, sulfuric acid is being pumped, and the pH is still above the set point, then pumping stroke length on the

sulfuric acid metering pump needs to be increased. Ensure that the pH begins to drop to the target level.

8. If mixer is damaged, replace it.
9. If mixer blades are obstructed, remove the obstruction by back flushing the mixer with water or compressed air.

5.16.2 Low pH

Narrowing the Problem

1. Check the effluent pH at the sample port with a portable pH sensor or pH paper.
2. Confirm that there is sufficient caustic in the storage tank (T-8).
3. Clean and calibrate the pH sensor.
4. Confirm that the caustic metering pump selector switches are in the “Manual” or “Auto” positions.
5. Confirm that the sulfuric acid metering pump selector switches are in the “Auto” or “Off” positions.
6. Confirm that the metering pump is set to receive a 4-20 mA signal from the PLC.
7. Confirm that the mixer (ME-110) is not damaged or that the mixing blades are not obstructed.
8. Confirm that the set points for the 4-20 mA signal from the pH analyzer (CIC-110) to the PLC are correct (Table 4-1 can be used for reference).
9. Confirm that the set points for the PID control loop are correct (Table 4-1 can be used for reference).

Corrective Actions

1. If the pH measured with the portable pH sensor is greatly different than the pH reading by CE-110, then either the CE-110 sensor is dirty, needs calibrating, or is not operating properly. Clean and recalibrate CE-110. If the pH reading by the cleaned sensor begins to match the portable pH sensor reading, then increase the frequency of maintenance for CE-110. If the pH still varies from the portable pH sensor, then CE-110 is potentially damaged and should be repaired or replaced.
2. If the caustic level in T-8 is low and/or the low level alarm in T-8 (LAL-8) is activated, order more caustic.

3. If the sulfuric acid metering pump is set to "Manual" mode, reset it to "Auto" mode. Ensure that the sulfuric acid metering pump stops and that the pH begins to rise to the target pH. If the sulfuric acid metering pump do not stop pumping ensure that it are set to pumps based on the PLC signal and not at a constant rate.
4. If caustic is not being pumped and the pH in T-3 is below the target level, then insure that the caustic metering pump is in either "Auto" or "Manual" mode and that the caustic supply piping is not plugged or leaking, does not contain air blocks, and all of the valves are open. If caustic is still not being pumped, the caustic metering pumps may be damaged. Follow the troubleshooting procedures in the metering pump manufacturer's manual (Volume 9).
5. If the set points for the 4-20 mA signal from the pH analyzer (CIC-110) to the PLC are incorrect (Table 4-1 can be used for reference), then set them to match the set points in Table 4-1.
6. If the set points for the PID control loop are incorrect (Table 4-1 can be used for reference), then set them to match the set points in Table 4-1.
7. If the caustic metering pump is in "Auto" mode, caustic is being pumped, and the pH is still below the set point, then pumping stroke on the caustic metering pump needs to be increased Ensure that the pH begins to rise to the target level.
8. If mixer is damaged, replace it.
9. If mixer blades are obstructed, remove the obstruction by back flushing the mixer with water or compressed air.

5.16.3 Recycle Valves not Working

Narrowing the Problem

1. Check the pH reading at the MMI and if the bypass has been activated.
2. Check if the high pH alarm (CAH-110) or low pH alarm (CAL-110) is activated.
3. Check if the recycle solenoid valves SV-110A and SV-110B are receiving electrical power

Corrective Action

1. Restore electrical power to SV-110A and/or SV-110B if needed.
2. If the pH is outside of the desired range, the high or low pH alarm is activated, then solenoid valve SV-101A and/or SV-110B are either not operating properly or not receiving a signal from the PLC. Follow the trouble shooting section of the solenoid valve manufacturers owner's manual to determine of the valve is broken or functioning incorrectly (Volume 9 of this manual). If the solenoid valve is not damaged, then contact an electrician to determine why the PLC is not relaying the alarm status correctly.

3. If the pH is outside of the desired range, the high or low pH alarm is not activated, then the PLC not receiving a signal from the CE-110. Contact an electrician to determine why the PLC is not relaying the alarm status correctly.

5.17 INORGANIC SLUDGE HOLDING TANK (T-5)

The purpose of the inorganic sludge holding tank (T-5) is to accumulate and store sufficient inorganic sludge for dewatering (pressing) and off-site disposal. The sludge holding tank receives sludge from the gravity phase separator (T-101), the oil/water separator (ME-1), and the lamella clarifier (ME-6). The level switch (LSH-5) in this tank activates an alarm (LAH-5) notifying the operator that the tank is full and needs to be decanted or pressed by the filter press. This switch also deactivates the sludge transfer pumps (P-12, P-13, and P-101) to eliminate further collection of sludge.

The sludge holding tank might not operate properly for the following reasons:

1. Tank overflows or high level alarm sounds.
 - Level switch (LSH-5) is not working properly.
 - PLC is not working properly.
2. Tank contains mostly water.
 - The sludge transfer pumps (P-12, P-13, and P-101) are operating too frequently.
 - Tank Overflows Or High Level Alarm Sounds

Narrowing the Problem

If the tank is overflowing, determine whether the alarm (LAH-5) has been activated and if any of the sludge transfer pumps (P-12, P-13, and P-101) are still transferring sludge.

Corrective Actions

1. If the alarm has been activated, the tank is not overflowing, and none of the sludge transfer pumps (P-12, P-13, and P-101) are pumping sludge, then the sludge needs to be decanted and pressed by the filter press (ME-12).
2. If the alarm has been activated and the tank is overflowing, then ensure that the sludge transfer pumps (P-12, P-13, and P-101) are disabled. If any of these pumps are enabled, then manually disable them and contact an electrician to determine why the PLC was not relaying the alarm status to the pumps. Decant tank T-5 and press the sludge with the filter press. When the sludge is pressed, place the pumps in "Auto" mode and continue normal operation. Also, as a precaution, monitor the plant influent for TSS to determine if there is a substantial increase in the TSS loading to the GWTP. If there is a significant increase, contact the project engineer for possible review of this increase.

3. If the alarm has not been activated and the tank is overflowing, then either the level switch or the PLC is working incorrectly:
 - Disable the sludge transfer pumps (P-12, P-13, and P-101) and close the valves on the sludge inlet pipes from these pumps.
 - Decant tank T-5 and press the sludge.
 - Inspect and clean the level switch. If the switch is damaged, replace it.
 - Operate one of the sludge transfer pumps in "Auto" mode. Manually activate the level switch. If the alarm is activated and the sludge transfer pump disengages, then open the valves in the sludge inlet pipes and operate as normal. If the alarm is not activated or the sludge transfer pump is not disabled, then the PLC is not relaying the alarm status. Disable the sludge transfer pump again and contact an electrician to determine why the PLC is not operating properly.

5.17.1 Tank Contains Mostly Water

If the sludge holding tank contains mostly water, then either the gravity phase separator (T-101) or the oil/water separator (ME-1) sludge transfer pumps (P-12, P-13, and P-101) are operating too frequently or for too long. Observe the pipes discharging into the sludge holding tank to determine the source of the water. Decrease either the pumping frequency or duration of the pump(s) at the MMI.

5.18 ORGANIC SLUDGE HOLDING TANK (T-104)

The purpose of the organic sludge holding tank (T-104) is to accumulate and store sufficient WAS sludge for dewatering (pressing) and off-site disposal. The organic sludge holding tank receives sludge from the WAS holding/digestion zones in the activated sludge plant (ME-101). The level switch (LSH-104) in this tank activates an alarm (LAH-104) notifying the operator that the tank is full and needs to be decanted and pressed by the filter press. This switch also deactivates the sludge transfer pump (P-101) to eliminate further collection of sludge.

The sludge holding tank might not operate properly for the following reasons:

1. Tank overflows or high level alarm sounds.
 - Level switch (LSH-104) is not working properly.
 - PLC is not working properly.
2. Tank contains mostly water.
 - The sludge transfer pump (P-101) is operating too frequently.
 - The sludge holding/digestion zones in that activated sludge plant are not decanted frequently enough.

- Too much sludge is being wasted resulting in a low MLSS concentration.
- There are general operational problems with the activated sludge plant.

5.18.1 Tank Overflows Or High Level Alarm Sounds

Narrowing the Problem

If the tank is overflowing, determine whether the alarm (LAH-102) has been activated and if the sludge transfer pump (P-101) is still transferring sludge.

Corrective Actions

1. If the alarm has been activated, the tank is not overflowing, and neither of the sludge transfer pump (P-101), then the sludge needs to be decanted and pressed by the filter press (ME-12).
2. If the alarm has been activated and the tank is overflowing, then ensure that the sludge transfer pump (P-101) is disabled. If this pump is enabled, then manually disable it and contact an electrician to determine why the PLC was not relaying the alarm status to the pump. Decant tank T-104 and press the sludge with the filter press. When the sludge is pressed, place the pump in "Auto" mode and continue normal operation. Also, monitor the MLSS concentrations in the reactor basins and clarifier of ME-101 and the RAS and WAS. If there is a significant change in these from historic operations, contact the project engineer for possible review of this problem and consult the Smith & Loveless O&M manual for the activated sludge plant contained in Volume 10.
3. If the alarm has not been activated and the tank is overflowing, then either the level switch or the PLC is working incorrectly:
 - Disable the sludge transfer pump (P-101) and close the valves on the sludge inlet pipe from this pump.
 - Decant tank T-104 and press the sludge.
 - Inspect and clean the level switch. If the switch is damaged, replace it.
 - Operate the sludge transfer pump in "Auto" mode. Manually activate the level switch. If the alarm is activated and the sludge transfer pump disengages, then open the valves in the sludge inlet pipes and operate as normal. If the alarm is not activated or the sludge transfer pump is not disabled, then the PLC is not relaying the alarm status. Disable the sludge transfer pump again and contact an electrician to determine why the PLC is not operating properly.

5.18.2 Tank Contains Mostly Water

If tank T-104 contains mostly water, then monitor the MLSS concentrations in the reactor basins and clarifier of ME-101 and the RAS and WAS. If there is a significant change in these from historic operations, contact the project engineer for possible review of this

problem and consult the Smith & Loveless O&M manual for the activated sludge plant contained in Volume 10 of this manual.

5.19 FILTER PRESS (ME-12)

For all problems associated with the filter press system, see the manufacturer's operation and maintenance manual located in Volume 9 of this manual.

5.20 OIL STORAGE TANK (T-6)

The purpose of the waste oil holding tank is to store oil until it is taken off-site for disposal. The waste oil holding tank receives oil from the gravity phase separator (T-101) and the oil/water separator (ME-1). A level switch (LSH-106) in this tank activates an alarm (LAH-106), notifying the operator that the tank is ready to be pumped.

The waste oil holding tank might not operate properly for the following reasons:

1. Tank overflows or high level alarm sounds.
2. Tank is full of water (rather than oil).

5.20.1 Tank Overflows or High Level Alarm Sounds

Narrowing the Problem

Determine whether the level switch has been activated.

Corrective Actions

1. If the tank is overflowing at a low flow rate (1-2 gpm) and the alarm is not on or the field is enabled, then:
 - Disable the field and close the valves on the waste oil inlet pipes from the oil/water separator and the clarifier.
 - Properly dispose of the contents of the waste oil holding tank.
 - Inspect and clean the level switch. If the switch is damaged, replace it.
 - Operate the field in "Auto" mode. Manually activate the level switch. If the alarm is activated and the influent pumps disengage, then open the valves in the waste oil inlet pipes and operate as normal. If the alarm is not activated or the influent pumps are not disabled, then the PLC is not relaying the alarm status. Disable the field again and contact an electrician to determine why the PLC is not operating properly.

2. If the tank is overflowing at a high rate (30-50 gpm), then the gravity phase separator or the oil/water separator is overflowing water to the waste oil holding tank. Close the waste oil inlet valves and follow the troubleshooting procedures in the gravity phase separator section or the oil/water separator section of this manual, whichever is appropriate. When the problem has been corrected, reopen the valves.

5.20.2 Tank is Full of Water (Rather Than Oil)

Narrowing the Problem

Determine if the tank is being filled with water and not oil.

Corrective Actions

The gravity phase separator and/or the oil/water separator is overflowing water to the waste oil holding tank. Follow the troubleshooting procedures in the appropriate section of this manual.

5.21 RECYCLE WATER HOLDING TANK T-4

Tank T-4 receives decant water from T-5, T-104, filtrate water from filter press, flow from the floor sumps and flow from the sand filter bed automatic backwash system. Effluent from T-4 is pumped to either the T-101 by pump P-10 or to the T-102 by pump P-9. These pumps are controlled a high and low level switches in the tank. A high tank level alarm is activated by level switch LSHH-4.

The equalization tank might not operate properly for the following reasons:

1. Tank overflows or high level alarm sounds.
 - High level switch (LSH-4) is not working properly.
 - PLC malfunctions.
2. Water is not being pumped out of T-4.
 - Valves are closed or check valves are not operating.
 - Level switches (LSH-4 or LSL-4) are not working properly.
 - Piping is plugged.
 - Pumps are off or not operating.
 - Sludge has built up in the tank.
 - PLC malfunctions.

5.21.1 Tank Overflows or High Level Alarm Sounds

Narrowing the Problem

1. Determine if the high level alarm (LAH-4) is activated.
2. Determine if pump P-9 or pump P-10 is pumping in "Auto" mode.
3. Temporarily operate P-9 or P-10 in "Hand" mode to determine if they can operate.

Corrective Actions

1. If the tank is overflowing, the alarm is not on, and either pump P-9 or pump P-10 is operating, then close the influent valves and pump down the tank. Clean LSHH-4 and manually activate the switch. If alarm LAH-4 activates, then open the influent valves and operate normally and increase the cleaning frequency for LSHH-4. If LAH-4 does not activate, then contact an electrician to determine why the PLC is not properly processing the alarm signal.
2. If the tank is overflowing, the alarm is activated or deactivated, and neither pump P-9 or pump P-10 is operating, then close the influent valves and:
 - Make sure that the pump discharge valves are open.
 - Operate one the pumps in “Hand” mode. If the pump operates, then partially pump down the tank in “Hand” mode and place pump back in “Auto” mode. Clean LSH-4 and manually activate the switch. If the pump operates, then open the influent valves and operate normally and increase the cleaning frequency for LSH-4. If the pump does not operate, then contact an electrician to determine why the PLC is not properly processing the “pump on” signal.
 - If the pump will not operate in “Hand” mode, then the effluent piping is plugged or the pump is damaged. Clean the piping and retry manual operation of the pump. If the pumps still does not operate, follow the trouble shooting procedures in the pump manufacturer’s O&M manual in Volume 7 of this manual. When the pump is repaired/replaced, clean LSH-4 and manually activate the switch. If the pump operates, then open the influent valves and operate normally and increase the cleaning frequency for LSH-4. If the pump does not operate, then contact an electrician to determine why the PLC is not properly processing the “pump on” signal.
3. If the tank is overflowing, the alarm is activated, and either pump P-9 or P-10 is operating, then close the influent valve and continue to pump the tank down. When the tank is pumped down, reopen the influent valves.

5.21.2 Water is Not Being Pumped from the Tank

Narrowing the Problem

1. Determine whether the water level in T-4 is above the low level (LSL-4) switch.
2. Confirm that the T-4 effluent valves are open.
3. Confirm that the pump(s) selector switches are in the “Hand” or “Auto” positions. If the pumps are not in the “Hand” position, turn them to “Hand” and confirm that they operate.

If there is sufficient groundwater in the tank to activate P-9 or P-10 and the selector switches for the pumps are in the “Hand” or “Auto” positions, then proceed as follows:

Corrective Actions

1. Determine whether pump P-9 or P-10 is operating.
2. If the pump(s) are operating but no water is being pumped, then the pump(s), pump effluent check valves, or piping is plugged, the pump(s) needs to be repaired.
3. If the pump is not operating, then the pump(s) need repair or the PLC is preventing the pump(s) from operating. Follow the trouble shooting procedures in the pump manufacture’s manual (Located in Volume 7 of this manual) and contact an electrician to confirm whether the PLC is preventing the pump from operating.

If there is insufficient groundwater in the tank but the pump(s) continue to run, then proceed as follows:

Corrective Actions

1. Confirm that the influent pumps are in “Auto” mode. If the pumps are in “Hand” mode, turn the selector switch to “Auto” mode.
2. Clean or replace the low level switch (LSL-4).
3. Confirm that the tank has not become partially filled with sludge. If the tank is full of sludge arrange to have the sludge removed.
4. If the low level switch is clean and operating properly and the tank has not accumulated sludge, then the PLC is not operating properly. Contact an electrician to determine why the PLC is not operating properly.

5.22 BACKWASH HOLDING TANK (T-1)

Tank T-1 receives treated water from the GWTP’s effluent piping, for backwashing activities for the sand filter beds (ME-8 and ME-9). Effluent from T-1 is pumped through the sand filter beds and to tank T-4 by pumps P-1 and P-2. These pumps are controlled as part of the automatic backwash system for ME-8 and ME-9 and the high and low level switches (LSH-1 and LSL-1) in the tank. A high tank level alarm is activated by level switch LSHH-1.

Tank T-1 might not function properly for the following reasons:

1. Tank overflows or high level alarm sounds.
 - High level switch (LSH-1) is not working properly.
 - PLC malfunctions.
 - Solenoid valve SV-208 not operating properly.

2. Water is not being pumped out of T-1.
 - Valves are closed.
 - Level switches (LSH-1 or LSL-1) are not working properly.
 - Piping is plugged.
 - Pumps are off or not operating.
 - Sludge has built up in the tank.
 - PLC malfunctions.
3. Tank is not filling with water.
 - Solenoid valve SV-208 not operating properly.
 - Solenoid valve SV-110A or SV-110B not operating properly.
 - PLC malfunctions.

5.22.1 Tank Overflows or High Level Alarm Sounds

Narrowing the Problem

1. Determine if the high level alarm (LAH-1) is activated.
2. Determine if solenoid valve SV-208 is open.

Corrective Actions

1. If the tanks is overflowing, solenoid valve SV-208 is open, and the high level alarm (LAH-1) is activated, then close the manual inlet valve to T-1 and determine if the solenoid valve or motor needs to be replaced. If the valve is damaged or the valve motor is burned out, then replace the damaged part.
2. If the tanks is overflowing, solenoid valve SV-208 is open, but the high level alarm (LAH-101) is not activated, then close then manual inlet valve to T-1 and manually pump tank T-1 down and manually test the high level switch LSH-1. If the switch is dirty, then clean it. If the switch is damaged, then replace it. Also, manually check the high high level switch (LSHH-1) and clean or replace if necessary. If the switches are not damaged contact an electrician to determine why the signals are not being transmitted from the switches to the PLC.
3. If the tank is overflowing, solenoid valve SV-208 is not damaged, and the level switches (LSH-1 and LSHH-1) work, then the PLC is not properly transmitting the open/close signal to SV-208. Contact an electrician to determine why the signal is not being transmitted.

5.22.2 Water is Not Being Pumped from the Tank

Narrowing the Problem

1. Determine whether the water level in T-1 is above the low level switch (LSL-1).
2. Confirm that the are open.
3. Confirm that the pump(s) selector switches are in the "Auto" positions.

4. Confirm that the sand filter bed automatic backwash system is not disabled.
5. Determine if water is entering the tank.
6. Check the sand filter bed inlet and effluent pressures to determine if the automatic backwash system should be engaged.
7. Confirm that there is not a high level alarm from tank T-4.

If the high level alarm (LAH-4) in tank T-4 is engaged, then proceed in accordance with Section 5.21 to correct the situation. The automatic backwash system should enable when the situation is corrected.

If there is sufficient groundwater in the tank to activate the sand filter bed automatic backwash system and the ME-8/ME-9 pressure indicators indicate that the automatic backwash system should be activated, then proceed as follows:

Corrective Actions

1. Determine whether P-1 or P-2 is operating.
2. If the pump(s) are operating but not pumping water then the pump(s), the effluent check valves or piping is plugged or one or more of the solenoid valves for the automatic backwash system is closed. Disable and clean pump(s), check valve, piping, and confirm that the solenoid valves for the automatic backwash system are in their correct position. If a valve(s) is in the correct position, then the pump(s) needs to be repaired. If a valve(s) is not in its correct position, then:
 - Determine if the solenoid valve mechanism is damaged. If it is damaged, then replace the valve mechanism(s).
 - Determine if the solenoid valve motor(s) is damaged. If it is damaged, then replace the motor(s).
 - If neither the valve(s) nor the motor(s) are damaged, then contact an electrician to determine why the open/close signal is not being transmitted to the valves.
3. If the pump is not operating, then the pump(s) need repair or the PLC is preventing the pump(s) from operating. Follow the trouble shooting procedures in the pump manufacture's manual (Located in Volume 7 of this manual) and contact an electrician to confirm whether the PLC is preventing the pump from operating.

If there is insufficient groundwater in the tank but the pump(s) continue to run, then proceed as follows:

Corrective Actions

1. Confirm that the influent pumps are in “Auto” mode. If the pumps are in “Hand” mode, turn the selector switch to “Auto” mode.
2. Clean or replace the low level switch (LSL-1).
3. Confirm that the tank has not become partially filled with sludge. If the tank is full of sludge arrange to have the sludge removed.
4. If the low level switch is clean and operating properly and the tank has not accumulated sludge, then the PLC is not operating properly. Contact an electrician to determine why the PLC is not operating properly.

5.23 CATALYTIC OXIDIZER/SCRUBBER (ME-106)

For all problems associated with the catalytic oxidizer/scrubber unit, see the manufacturer’s operation and maintenance manual located in Volume 10 of this manual.

5.24 FLOOR SUMPS

Water from floor washing operations and from spills will drain into the below ground treatment room sumps (North, Middle, South, and Filter Press). The sumps are equipped with submersible pumps that are controlled by an internal level controller. Upon detecting a high water level in the sump, the level controller will activate the pump to pump the groundwater to T-4). If any of the floor sumps cannot maintain the water level within the sump below a high-high level mark, a high-high level switch within the sump will activate an alarm and shut-off the field pumps, P-3, P-4, P-5, P-9, P-10, P-104, and P-105.

The treatment room sumps may not work properly for the following reasons:

1. Sump overflows or high level alarm is activated.
 - High level switch is not working properly.
 - PLC is not working properly.
 - Discharge piping is plugged.
 - The pump’s internal float switch is tangled.

5.24.1 Sump Overflows or High Level Alarm is Activated

Narrowing the Problem

1. Check if high level alarm for the sump has been activated.
2. Check if the sump pump is operating.

3. Check if pump's internal float switch is tangled.
4. Identify the source of the water.
5. Check if the sump inlet is plugged with solids/sediment.

Corrective Actions

1. Identify the source of the water and correct the situation in accordance with the appropriate section of this manual.
2. If the sump is overflowing, the alarm is on, and float switch is tangled, untangle the switch to all free motion.
3. If the sump is overflowing, the alarm is on, float switch is not tangled, but the sump pumps is not pumping, then:
 - Determine if the pump inlet is clogged. Unclog is needed.
 - If the pump is clean and operating, but not discharging water, then ensure that the valves in the pipe to T-4 are open and that the pipe is not clogged. Clean pipe if needed.
 - If the pump is not operating (humming, vibrating), ensure that it is receiving electrical power and repair/replace the pumps if needed in accordance with the manufacturer's O&M manual.
4. If the sump is overflowing, the alarm is on, float switch is not tangled, and the sump pumps is pumping slower than usual, then clean the pump and piping.

5.25 BLOWERS

The purpose of the blowers is to provide air for the diffuser systems in T-102 and ME-101. For problems with blowers ME-102 and ME-103 (the 100-hp blowers) see the Smith & Loveless O&M manual for the activated sludge plant located in Volume 10 of this manual. For problems with blowers ME-104 and ME-105 (the 30-hp blowers) see the blower O&M manual located in Volume 10 of this manual.

5.26 AIR COMPRESSOR

For problems with air compressor ME-24 see the see the air compressor manufacturer's O&M manual located in Volume 6 or 7 of this manual.

5.27 FLOW METERS

There are two types of flow meters at the GWTP: magnetic-type and turbine-type. Each type is subject to different problems. Flow meters FM-801, FM-803, FM-108, and FM-109 are magnetic flow meters and the rest are turbine type.

5.27.1 Magnetic Flow Meters

Problems

1. The flow meter does not have electrical power.
2. The measured flowrate is incorrect.
3. The flowrate is not being transmitted to the PLC.

Corrective Actions

1. If there is no flow but the flow meter reads a flowrate or if there is a flow but the flow meter does not read a flowrate, re-calibrate or replace the flow meter following the flow meter manufacturer's manual (Volume 5 of this manual).
2. If the flow meter does not have electrical power, look for damaged or unconnected wires. Either replace/reconnect the wire(s) or contact an electrician to replace/reconnect the wire(s).
3. If the flowrate is not being transmitted to the PLC, then look for damaged or unconnected signal wires. Either replace/reconnect the wire(s) or contact an electrician to replace/reconnect the wire(s) if the wires are the cause of the problem, or contact an electrician to determine why the PLC is not receiving the signal.

5.27.2 Turbine Flow Meters

Problems

1. The flow meter does not have electrical power.
2. The measured flowrate is incorrect.
3. The flowrate is not being transmitted to the PLC.
4. The flow meter is blocking the flow.

Corrective Actions

1. If there is no flow but the flow meter reads a flowrate or if there is a flow but the flow meter does not read a flowrate, re-calibrate or replace the flow meter following the flow meter manufacturer's manual (Volume 5 of this manual).
2. If the flow meter does not have electrical power, look for damaged or unconnected wires. Either replace/reconnect the wire(s) or contact an electrician to replace/reconnect the wire(s).
3. If the flowrate is not being transmitted to the PLC, then look for damaged or unconnected signal wires. Either replace/reconnect the wire(s) or contact an

electrician to replace/reconnect the wire(s) if the wires are the cause of the problem, or contact an electrician to determine why the PLC is not receiving the signal.

4. If it is known that there is flow through the flow meter and there is no indication on the flow meter that water is flowing and/or if the flow meter is blocking the flow, remove the flow meter and clean the interior to remove solids from the turbine. Increase the frequency that the flow meters are cleaned. If the problem persists, all of the turbine flow meters contain a section pipe that can be replaced with a screen, and a screen should be added.

6.0 PROCESS MONITORING

To monitor system performance, determine and set optimum operation conditions a system monitoring plan will be followed. The monitoring plan will consist of sample collection and analysis of key parameters and specific locations along the treatment train. The monitoring sampling will be conducted in addition to required regulatory monitoring for the NPDES equivalency, and IDEM air emission requirements. The monitoring plan is divided into three operational phases for the GWTP: start-up, acclimation, and steady state. The monitoring requirements and duration of each state is described below.

In addition to process monitoring through sample collection and analytical analysis, it is necessary to perform on-site monitoring and documentation of groundwater levels, flowrates, pH levels, chemical addition rates, sludge generation rates, and any process interruptions or changes in order to keep the system operating efficiently.

6.1 PROCESS MONITORING

6.1.1 Startup/Implementation Monitoring

The start-up stage will consist of the initial system start-up. The samples collected during the start-up phase will be used as a base line for initial operation of the system and its individual components. They will also be used as a guide to determine required adjustments to the groundwater collection system such as influent flow rates and collection locations. The start-up stage is intended to be a one-time event with the samples collected along the treatment train at times sufficient to allow for the residence times of each component of the system. The sample locations and parameters are contained in Table 6-1. Please note that these samples are to be collected when the upgraded GWTP first begins to treat collected BWES and PGCS groundwater. The samples should be collected in order of treatment (gravity phase separator influent and effluent first, oil/water separator second, aerated equalization tank third, etc.) to ensure that the samples are representative of actual influent to the GWTP. Note: allow time for the water to pass through the components before collecting the effluent samples and moving on to the next component.

6.1.2 Acclimation Monitoring

The acclimation stages of the monitoring plan will occur during the first four weeks after initial system start-up and each change in each dewatering scenario (see Table 1-1 for schedule). The purpose of monitoring during the acclimation stages is to monitor the system performance during these significant changes in influent and determine any operational changes needed to optimize system performance. The most critical component to monitor during significant influent changes is the activated sludge. Acclimation monitoring needs to be performed to monitor the acclimation of the activated sludge to the new influent and ensure that the new contaminant loadings and nutrients are within the desired range for the activated sludge plant. The sample locations and parameters for the acclimation stages are detailed in Table 6-1.

6.1.3 Steady State Monitoring

Steady state monitoring will begin at the completion of each acclimation monitoring stage. The purpose of steady state monitoring is to ensure optimal continued operation of the system and adjust the system as necessary to accommodate any unplanned changes to the influent flow. The initially planned samples are detailed in Table 6-1. The analytes and frequency of sampling during this monitoring stage may need to be updated based on influent and treatment trends.

6.2 COMPLIANCE MONITORING

Compliance monitoring must be conducted to ensure that the facilities are successfully meeting their intended objectives. Compliance monitoring will also aid in optimizing operation of the groundwater treatment system to ensure continued compliance with the discharge permit requirements.

Compliance monitoring for the GWTP will be conducted in accordance with the *Performance Standard Verification Plan* included in Volume 2 of this manual and revised in the *Quality Assurance Project Plan* (MWH, November 2001). A summary of the GWTP compliance sampling requirements is presented in the table below:

Analyte	Frequency
Flowrate and pH	Continuous
BOD, TSS, SVOCs, and Metals	Once per quarter
VOCs	Once per month
PCBs	Once per quarter
PCBs in Sediment (one location)	Annually

It is recommended that the compliance sampling for BOD, TSS, SVOCs, metals, and PCBs be conducted on a monthly basis until the GWTP is operating in a fairly steady state.

6.3 OPERATION AND MAINTENANCE LOGS

Establishing and maintaining a complete facility records system is vital to an efficient operation and maintenance of the treatment facility. Proper record keeping will fulfill the regulatory reporting requirements, create a baseline and criteria for the planning of facility expansions or continued operation, benefit performance evaluation and remedies to periodic treatment problems, and assist in estimating and scheduling maintenance activities and budgets. All required documentation must be kept at the on-site office and a copy of the records must be submitted to the engineering manager.

6.3.1 Daily Activity Reports

The details of daily operations are to be summarized and recorded using the daily activity report worksheets. The worksheet is used to record the time of the day, activities that took place, any sampling and analytical results, visual observations, and any calculations. The worksheets will also serve as a reminder of routine activities and inspections to be conducted at the treatment facility.

6.3.2 Operation Log

The operator for the extraction and treatment facilities should maintain a bound diary/journal-type logbook or computer document file. Typical instrument readings, startup or shutdown of equipment, occurrence of accidents, major breakdowns, commencement and completion of major maintenance efforts, chemical deliveries, changes in operation, and monitoring sampling should be included in the operation log. Log entries of various activities and problems should be made as they develop so that no items are overlooked.

Data monitored by the PLC will be electronically maintained by the MMI for 90 days. Printouts of this data may be incorporated by reference into the logbook.

6.3.3 Summary Records

A summary record is useful in identification of operational trends and forecasting of problems. For most operations, a monthly log arranged in the chronological order and showing equipment performance, chemical consumption, and other facility activities should be included in the summary records.

Data monitored by the PLC will be electronically maintained by the MMI for 90 days. Printouts of this data may be incorporated by reference into the monthly log.

6.3.4 Cost Records

The maintenance of complete cost records is valuable for use in the budgeting and planning efforts. The costs should include utility usage, chemical and shipping costs, equipment rental, and usage costs. Records defining the allocations and costs of labor for the facility should also be maintained.

6.3.5 Progress Reports

Progress reports must be prepared to transfer operations information from the operators to the ACS Technical Committee and the engineering manager. The progress reports must be submitted to the engineering manager on a monthly basis along with any laboratory data reports.

6.3.6 Compliance Monitoring Reports

Compliance monitoring reports must be prepared and submitted to the regulatory agencies on a quarterly basis. In addition, summaries of the water level data, effluent sample data, and pump discharge data will be forwarded to the agencies on a monthly basis in the monthly status report. The engineering manager or project manager will prepare and

submit the quarterly reports, but the operators must provide the information required in accordance with the PSVP along with the progress reports.

6.4 LABORATORY REPORTS

Proper performance and interpretation of laboratory analyses will enable the operations staff to maximize efficiency and effectiveness of the various unit processes. Laboratory analyses are also performed to ascertain whether or not compliance with the discharge standards is being achieved; such results shall be reported to the U.S. EPA and the IDEM in accordance with the PSVP and QAPP (MWH, November 2001).

The reporting program requires an adequate record keeping plan in order to maintain credibility. The following are recommended record keeping guidelines, to be exercised at GWTP.

6.4.1 Sample Logs

Before any sample is collected, a significant amount of planning must be performed, as discussed earlier in this document. The tool utilized to structure this planning is a sample log. Through a sample log the sample stream, size, collection time and method, mode of preservation, and analysis schedule can all be predetermined, and all quality assurance requirements can easily be fulfilled.

A sample log will be completed for each sample acquired at the extraction and treatment facilities with the following information written in indelible ink:

- Sample type (compliance, process, etc.)
- Sample name and/or flow stream;
- Type of sample (grab or composite);
- Date and time of collection;
- Sampling location;
- Analyte(s) or analytical method(s); and,

The sample logs will be maintained electronically in a computer database.

6.4.2 Chain-Of-Custody

The chain-of-custody procedures allow for the tracing of possession and handling of individual samples from the time of field collection through laboratory analysis. Documentation of custody is accomplished through a chain-of-custody (COC) record that lists each sample and the individuals responsible for sample collection, shipment, and receipt. A sample is considered in custody if it is:

- In a person's possession
- In view after being in physical possession

- Locked or sealed so that no one can tamper with it after having been in physical custody.
- In a secured area, restricted to authorized personnel.

A COC form will be used to record the samples collected and the analyses requested. Information recorded will include time and date of sample collection, sample number, the type of sample, the sampler's signature, the required analysis, and the type of containers and preservatives used.

A copy of the COC record will be retained by the sampler prior to shipment. Shipping receipts will be signed and filed as evidence of custody transfer between field sampler and courier, and the courier and laboratory.

7.0 MAINTENANCE PLAN

Maintenance performed at the facility can be categorized into four general classifications described below.

7.1 SPARE PARTS MANAGEMENT

Each major piece of equipment at the facility is provided with critical spare parts to accommodate for emergency repairs. Table 7-1 provides an inventory of recommended spare parts and is based on the equipment manufacturer's recommendation.

When establishing the initial spare parts list, the plant operator should assemble inventory for special tools to ensure the proper tools are used when performing the required maintenance procedures.

7.2 PREVENTATIVE MAINTENANCE

Preventive maintenance is the most crucial program to ensure proper, long-term operation of the system components. It involves service maintenance tasks to prevent or minimize process shut down, to reduce wear on all equipment, and to extend the useful life of equipment and structures.

Preventive maintenance requirements for primary equipment are listed on Table 7-2. Refer to equipment manufacturer's literature for further details. All maintenance should be conducted by trained and authorized personnel and in accordance with the equipment manufacturer's recommendations.

7.3 ROUTINE MAINTENANCE

Routine maintenance (or facility housekeeping) involves the care of the facility building as well as the mechanical equipment. Routine maintenance of the mechanical equipment should be conducted as needed or as specified by the equipment manufacturer.

Walkways and stairways within the facility should be kept clear of debris and hosed down periodically for reasons of health and safety. The laboratory, office, instrumentation room, mechanical room, and other work areas should be cleaned regularly and kept in good order.

7.4 CORRECTIVE MAINTENANCE

Corrective maintenance is all work required to repair major equipment malfunctions including complete overhauls and emergency repairs. Maintenance personnel should be prepared to handle this type of emergency work at all times to ensure continuity of the facility operation.

A major item of concern with the execution of corrective maintenance is that these maintenance tasks are generally more complex, thereby requiring more expertise and mechanical aptitude to complete the job. The operator must determine if the work needed to be done can be accomplished by in-house personnel or must be contracted out to a specialized service contractor.

7.5 GENERAL MAINTENANCE REQUIREMENTS

All maintenance requires considerable skill acquired by experience, study, and practice. All maintenance programs should incorporate a good housekeeping program and should serve the following rules:

- Keep a clean, neat, and orderly operating facility.
- Establish a systematic plan for the execution of regular operations.
- Establish a routine schedule for inspections and lubrications.
- Keep data and records of each piece of equipment, with emphasis on unusual incidents and faulty operating conditions.

Performance of the day-to-day maintenance functions is only one obligation of maintenance personnel. There is the obligation of record keeping on each individual piece of equipment, to include all work performed on that particular unit, along with comments on the overall condition and operating characteristics. Analysis of these records assists in the detection of an impending failure of the piece of equipment and subsequent scheduling of its repair in a timely manner.

7.5.1 Observation of Field Safety

Each operator should be aware of the dangers and restrictions involved when performing maintenance on any piece of equipment. Employees can be injured on the job from the misuse of tools, lifting heavy objects incorrectly, and/or handling chemical without taking necessary precautions.

7.6 PLANNING AND SCHEDULING

A key to properly maintaining facility operation is detailed planning and scheduling of maintenance functions to be performed. Planning and scheduling should consider tasks to be performed, time required, personnel skills, special tools or equipment required, work

order lead times, availability of parts, environmental factors, parts reorder lead times, equipment replacement schedules, vacations, holidays, and availability of personnel. Scheduling charts with priorities of subjects, personnel, and time should be used as a planning tool so as to maximize resources and personnel and to help minimize idle time and wasted effort. Those tasks to be performed at a specified interval such as daily, weekly, or monthly, may be grouped accordingly for work scheduling purposes.

8.0 EMERGENCY RESPONSE AND CONTINGENCY PLAN

8.1 PURPOSE

The purpose of the Emergency Response and Contingency Plan (ERCP) is to define procedures to protect human health and the environment both on and off-site in the event of an accident or emergency during the GWTP operation and maintenance activities. The ERCP presents procedures and policies to be implemented during O&M phase and delineates the responsibilities for the facility O&M contractor. Any future changes to the ERCP shall be documented by the O&M contractor as addendum to this ERCP. It's the O&M contractor's responsibility to implement the ERCP.

Emergencies can take many forms: illness or injuries, chemical exposures, fires, explosions, spills, leaks, releases of harmful chemicals, or sudden changes in the weather. It is imperative that facility personnel be prepared in the event of an emergency.

8.2 ELEMENTS OF THE EMERGENCY RESPONSE AND CONTINGENCY PLAN

This ERCP has been developed in accordance with the guidelines presented 29 CFR 1910 Part 120(1) and addresses the following elements:

- Pre-emergency planning
- Personnel roles, lines of authority, and communication
- Emergency recognition and prevention
- Safe distances and place of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination
- Emergency medical treatment and first aid
- Emergency alerting and response procedure
- Critique of response and follow-up
- Personal protective equipment and emergency equipment

The ERCP addresses these elements for normal operations and abnormal shut down of the PGCS and BWES facilities. In addition, the ERCP meets the guidelines provided in *"Guidance on EPA Oversight Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties, Appendix B, Contingency Plan (U.S. EPA, 1990)."* As suggested by U.S. EPA, the ERCP includes elements to protect the local affected population in the event of an accident or emergency, such as:

- Name of the person responsible for responding to an emergency accident
- Plan and date for meeting with the local community

- First-aid and medical information
- Air monitoring plan
- Spill control and countermeasures

8.3 PRE-EMERGENCY PLANNING

There will be a pre-emergency planning meeting during which Site personnel will be supplied with a copy of this ERCP and the Health and Safety Plan (HASP). The Site Safety Officer (SSO) will discuss Site operations and the workers will be instructed in the recognition, avoidance, and prevention of unsafe activities and conditions. Emergency procedures will be discussed during the meeting.

The pre-emergency planning meeting will also discuss the role and responsibilities of key personnel and lay down the lines of communications. Each personnel assigned to the site will be trained in conformance with pertinent OSHA regulations including 29 CFR 1910.120.

8.4 KEY PERSONNEL AND RESPONSIBILITIES

The following describes the role and responsibilities of key personnel assigned to GWTP operation and maintenance.

8.4.1 Project Manager

As Project Manager (PM), Dr. Peter Vagt, P.G. will be overall responsible for the GWTP O&M activities, for assigning field personnel and interacting with the operations staff on a regular basis, and for ensuring that all activities are conducted in a safe manner and in accordance with approved documents. He will also be responsible for communicating information to the ACS Steering Committee and the regulatory agencies Project Coordinators per a mutually agreed-upon schedule.

8.4.2 Site Safety Officer

Mr. Lee Orosz will be responsible for maintaining proper medical surveillance, providing hazard communication information, training employees in safe operating procedures, and advising the PM on any matters concerning the health and safety of the employees or the public. The Site Safety Officer (SSO) may be required to perform various types of area or personnel monitoring for purposes of determining worker exposure and proper selection of personal protective equipment (PPE) if unforeseen chemical hazards are encountered. The SSO should be consulted when any changes in the recommended procedures or levels of PPE are made.

8.4.3 Lead Operator

Mr. Lee Orosz will be the lead operator responsible for day-to-day operations of the GWTP. In this capacity, he will be responsible for ensuring that all system components work as designed and that the extraction and treatment facilities operate in accordance with the design criteria. He will also be responsible for the facility maintenance including scheduled and equipment maintenance, replacement parts ordering and stocking, facility start up and shut down, on-site analytical work, and preparation of the operation logs.

8.4.4 Engineering Manager

Mr. Robert A. Adams, P.E. will be responsible for the successful execution and administration of all engineering-related activities at the GWTP. Primary responsibilities include development of operational procedures and updating the procedures as needed, incorporating changes to the facility design to enhance the system performance, preparation of agency submittals to document changes and additions, and for ensuring that the sampling and analysis plan is implemented per the approved documents.

8.4.5 Operations Manager

Mr. Todd Lewis will be overall in charge of the GWTP operation and maintenance. In this capacity, Mr. Lewis will direct the lead operator for day-to-day activities, coordinate with SSO to ensure safe operating environment, and advise the PM on matters concerning the facilities operation. He will also interact with the Project Manager and Engineering Manager during implementation of potential changes to the system design.

8.4.6 Project Personnel Contact Numbers

Contact Name	Project Role	Business Phone	Residence Phone
Peter Vagt	Project Manager	(630) 836-8923	(630) 665-4629
Lee Orosz	Site Safety Officer/ Supporting Operator	(219)924-4607	(219) 947-5228
Lee Orosz	Lead Operator	(219) 924-4607	(219) 947-5228
Robert Adams	Engineering Manager	(630) 636-8957	(630) 761-3261
Todd Lewis	Operations Manager	(630) 836-8924	(708) 424-0891

8.5 SITE SECURITY PLAN

Security measures have been implemented to minimize the possibility for unauthorized entry to the extraction and treatment facilities. The access road is blocked by a locked chain-link fence and gate with barbed wire to control access. The treatment facility is housed inside a building that will remain locked at all times when no operating personnel are present. The main entrance to the building will remain closed to prevent unauthorized entry. Personnel entering the GWTP building will park outside the building and will not be allowed to enter the building until signing in

with the operations personnel. A sign stating "Warning - Unauthorized Personnel Keep Out," will be posted at the building entrance. A set of keys to the building will be kept by the following people:

- Site Safety Officer
- Lead Operator
- Project Manager

If there has been a security violation, the PM will be notified immediately. The PM will be responsible for notifying the ACS Steering Committee and for initiating further measures. The operations personnel will prepare a written statement describing the events of the security violation within 24 hours of the incident and submit the statement to the PM. The report content will include the nature of security violation, approximate time period of the event, impact of security violation on the facility, and if a facility shut down may be required.

8.6 GENERAL SAFETY

This section presents some of the safety hazards associated with operation of the GWTP and is not intended to be all-inclusive. The Site HASP and the Health and Safety Plan Addendum contain more extensive safety information relative to the activities that commonly occur at the Site and should be consulted.

Proper safety procedures and equipment cannot be overemphasized. System operators must acquaint themselves with the hazards associated with system maintenance and operation, and take the necessary steps to avoid them.

8.6.1 Oxygen Deficiency

Oxygen deficiency can occur in any confined space such as the equalization tank, sludge storage tank, building sumps, or GAC units. Oxygen deficiency is an asphyxiation hazard which results when some other gas replaces air, whether it is toxic or not. The necessary precautions should be taken to assure ample ventilation when entering any confined space. More specific instructions and a confined space entry permit are included in the Site HASP. Before entry into a confined space these instructions should be reviewed and a confined space permit should be completed and filed.

8.6.2 Chemical Hazards

This section provides a summary of chemical hazards for chemicals that will be routinely stored at the site. A material safety data sheet (MSDS) for each chemical is included at the end of this section. Chemicals planned to be routinely used at the site include:

Sodium Hydroxide. Sodium hydroxide (NaOH) is added to the water to increase the pH and cause precipitation of metal hydroxides. 50-percent solution of sodium hydroxide is purchased in bulk. The solution is also known as lye or caustic soda. NaOH is extremely

alkaline and is very corrosive to body tissues and may cause burns. If the solution comes into contact with the eyes or skin, immediately flush the affected area with water and if necessary seek medical help. When working with the solution, personnel should wear protective clothing such as gloves, face shields and rubber aprons. A weak acid solution such as vinegar can be used to neutralize NaOH spills.

Sulfuric Acid. Sulfuric acid (H_2SO_4) is added to the water to adjust the pH of the water following the precipitation system. 93-percent acid is purchased in bulk. The acid is highly corrosive and may burn the eyes, skin and mucous membranes. Ingestion may be fatal. If the acid comes into contact with the eyes or skin, immediately flush the affected area with water and/or sodium bicarbonate solution and if necessary seek medical help. When working with the acid, personnel should wear protective clothing such as gloves, boots, face shields and rubber aprons. Respiratory protection should be worn when there is the possibility of exposure to acid vapors. A supply of sodium bicarbonate (baking soda) should be kept on-site to neutralize any acid spills.

Phosphoric Acid. Phosphoric acid (H_3PO_4) is used as a nutrient supplement for the biomass in the activated sludge plant. 75-percent acid is purchased in bulk. The acid is corrosive and may burn the eyes, skin and mucous membranes. Ingestion may be fatal. If the acid comes into contact with the eyes or skin, immediately flush the affected area with water and/or sodium bicarbonate solution and if necessary seek medical help. When working with the acid, personnel should wear protective clothing such as gloves, boots, face shields and rubber aprons. Respiratory protection should be worn when there is the possibility of exposure to acid vapors. A supply of sodium bicarbonate (baking soda) should be kept on-site to neutralize any acid spills.

Ammonium Hydroxide. Ammonium hydroxide (NH_4OH) will be used as a nutrient supplement for the biomass in the activated sludge plant. 30-percent ammonium hydroxide is purchased in bulk. Ammonium hydroxide is corrosive and may burn the eyes, skin and mucous membranes. Ingestion and/or inhalation may be fatal. If the caustic comes into contact with the eyes or skin, immediately flush the affected area with water and seek medical help. When working with ammonium hydroxide, personnel should wear protective clothing such as gloves, boots, face shields and rubber aprons. Respiratory protection should be worn when there is the possibility of exposure to acid vapors.

Nitric Acid. Nitric acid (HNO_3) may be used as a nutrient supplement for the biomass in the activated sludge plant. 75-percent acid is purchased in bulk. The acid is corrosive and may burn the eyes, skin and mucous membranes. Ingestion may be fatal. If the acid comes into contact with the eyes or skin, immediately flush the affected area with water and/or sodium bicarbonate solution and if necessary seek medical help. When working with the acid, personnel should wear protective clothing such as gloves, boots, face shields and rubber aprons. Respiratory protection should be worn when there is the possibility of exposure to acid vapors. A supply of sodium bicarbonate (baking soda) should be kept on-site to neutralize any acid spills.

Chemical Safety Equipment. Three emergency eyewash and safety showers are provided. One is located outside at the chemical delivery truck pad. The second is located inside near the chemical storage area by the UV-Oxidation Unit for use in the event of an accident involving any of the chemicals used in the facility. The third is located near the chemical storage area by the Catalytic Oxidizer Unit. As previously mentioned, personnel should wear protective clothing such as chemical resistant gloves, boots, face shields and rubber aprons when working with any of the chemicals. Drums containing chemicals should be stored in designated and delineated areas and should be placed on containment pallets when opened to catch any drips. Several 50-pound bags of sodium bicarbonate should be kept on-site for use in neutralizing spills of acid or base. A commercial spill containment kit with adsorbents and containment supplies should also be maintained at the facility.

8.7 AIR MONITORING PLAN

Volatile organic compounds will be monitored during the GWTP operation. Emissions monitoring will be conducted in accordance with the guidelines established by the local regulatory agencies. Portable field equipment will be kept at the site to adequately characterize the vapors and to plan for personal protective equipment.

8.8 SPILL AND DISCHARGE CONTROL PLAN

The GWTP is designed to treat extracted groundwater; hence a potential exists for spill of contaminated groundwater. In addition, several chemicals are to be stored on-site to treat extracted groundwater and to analyze treated groundwater. This spill and discharge control plan addresses methods, means, and facilities provided to: (1) prevent a spill or uncontrolled discharge of contaminated groundwater or chemicals, (2) prevent further contamination of the environment, structures, equipment, or materials resulting from potential accidental spills, (3) protect the ACS employees from potential hazards at the site, and to (4) ensure public health and safety.

8.8.1 Control Procedures and Protective Measures

The GWTP design incorporates secondary containment systems to contain spilled material. Equipment is provided to perform emergency measures necessary to contain spills and to remove spilled materials and associated contaminated material. A spill kit is to be maintained on site. The spill kit contains a DOT-approved container, sorbing material, shovels and brooms, personnel protective clothing (Tyvek, gloves, safety glasses, and industrial boots), and adequate polyethylene sheeting to contain a spill. The waste generated as a result of any spill will be collected on site, properly containerized, and either treated through the GWTP or transported to an authorized off-site disposal facility.

8.8.2 Decontamination Procedures

Decontamination procedures may be required after cleanup to eliminate traces of the substances spilled or to reduce it to an acceptable level. Personnel and equipment decontamination shall occur as specified in 29 CFR 1910.120.

8.8.3 Spill Notification

In the event of a spill, the facility operator(s) shall take the following actions:

1. Assess the need to don a higher level of PPE. This assessment will depend on the volume of the spill, nature of the spilled material, and measurements from air monitoring equipment.
2. In the event that the spill is too large to be handled safely by the facility operator, the area around the spill should be secured. The Site Safety Office (SSO) should initiate clean-up activities by notifying the appropriate emergency or spill response organization.
3. Immediately notify officials at the ACS facility (219-924-4370) so that proper precautionary measures can be taken to protect ACS employees.
4. Control and Contain the Spill: Operator should anticipate the type of spill control materials they may need in advance of mobilization. Spill control materials include spill pillows, pigs (long absorbent tubes), neutralizing chemicals for caustic and acidic spills, activated carbon for organic spills, non-sparking shovels, and overpack drums or inert drum liners.
5. Initiate Spill Clean Up: Pump or scoop up the spilled material and affected soil or articles, and placing the material in a drum or other suitable container. This should be done in the appropriate level of PPE.
6. For groundwater spills, the area affected by the spill should be minimized by diking and any free water should be cleaned up. Sampling of the affected area should then be carried out to confirm clean up to the desired levels.
7. Decontaminate the Tools and Personnel: Drums or other containers should be on site to store decontamination fluids and waste PPE. All field team members should exercise care when decontaminating equipment and personnel, and should treat any spilled decontamination water or fluid as a hazardous material.
8. Once efforts to mitigate the spill are underway, notify the ACS Steering Committee of the nature of the spill and the response action. The ACS Steering Committee is responsible for notifying the regulatory agencies within 10 days of any unauthorized spill in accordance with the requirements of 49 CFR 171.15 and other regulatory requirements. 49 CFR 171.15 requires regulatory notification of unauthorized spills which exceed 450 liters (119 gallons) for liquids and/or 400 kg (882 pounds) for

solids, and could be used as a threshold for regulatory notification. The reportable quantities for the major chemicals used at the site are:

Sulfuric Acid	-	2,000 gallons
Sodium Hydroxide	-	2,000 gallons
Phosphoric Acid	-	350 gallons
Ammonium Hydroxide	-	350 gallons

8.9 EMERGENCY ASSISTANCE INFORMATION

8.9.1 General Procedures

The following procedures shall be followed in the event of an emergency:

- In accordance with 29 CFR 1910.120(1), the operator or operations contractor should establish facility evacuation routes and an emergency medical assistance network.
- The fire department, ambulance service, and clinic or hospital room should be identified and phone numbers for these services posted in a conspicuous place within the facility.
- The SSO will inform the local medical facility before site operations commence. The SSO will provide the medical facility general information of on-site chemical hazards that may be encountered, in addition to Site location and time of work activities.
- Every attempt to rapidly identify substances to which the worker has been exposed shall be made. This information will be given to medical personnel in the event of an emergency.
- Procedures for decontamination of injured workers and preventing contamination of medical personnel, equipment, and facilities shall be communicated to the workers.

Emergency assistance information is provided in this section and a map delineating the route to the closest emergency room is shown in Figure 8-1. A vehicle shall be available on site during work hours to transport injured personnel to the emergency hospital.

8.9.2 Emergency Hospital

Munster Community Hospital (219) 836-1600
901 McArthur Boulevard, Munster, Indiana

Driving Directions to Hospital: Exit site onto Colfax north to 45th Ave. Turn left (west) onto 45th Ave. Turn right (north) onto Calument Ave. Hospital emergency entrance is on east side of the street, just pass Fisher Street. See Figure 8-1 for a hospital location map.

8.9.3 Emergency Contact Numbers

American Chemical Service	(219) 924-4370
Ambulance	911
Fire and Rescue	911
Highway Patrol	911
Paramedics	911
Police	911
Sheriff	911
Toxic Chemical Spill	(800) 334-1697
EPA Emergency Response	(312) 353-2318
Poison Control	(800) 942-5969
National Response Center	(800) 424-8802

8.9.4 Emergency Equipment and First Aid

The following emergency equipment shall be maintained at the GWTP:

- First-aid equipment and supplies
- Type ABC fire extinguisher, 10-pound capacity. A minimum of two fire extinguishers should be kept at the site at all times.
- Emergency eyewash station and shower are located in the treatment facility
- Emergency use respiratory equipment sufficient to protect the operator from particulates, organic vapors and acidic or corrosive gases

The first aid shall include the following at a minimum:

- Disposable mouth-to-mouth resuscitator
- Disposable gloves and overgarments
- Safety goggles and face mask

Whenever first aid procedures are performed on another person, the Site Safety Officer must be notified as soon as possible.

8.9.5 Personal Protective Equipment

The following outlines the PPE to be utilized at the GWTP:

- Safety Boots - Steel toe/steel shank
- Hard Hat
- Safety Glasses with wide shields
- Face Shield
- Hearing Protection
- Tyvek[®] suits
- Nitrile gloves (or other equivalent)

8.9.6 Medical Emergency Procedures

Any person who becomes ill or injured must be decontaminated as soon as possible, giving consideration to which risk will be greater, the spread of contamination or any potential health effects of the individual. If the victim is stable, decontamination is to be completed and First Aid administered as needed prior to transport. If the patient's condition is unstable, only gross decontamination is to be completed (i.e., removal of PPE if necessary), to prevent injury to responder, prior to administering First Aid. First Aid should be administered while awaiting an ambulance or paramedics as appropriate to the injury.

Anyone being transported to a clinic or hospital for treatment should have available to them information on any potential chemical(s) to which they could have been exposed at the Site, along with their medical history.

8.10 COMMUNITY RELATIONS PLAN

As part of pre-emergency planning, the O&M contractor will work with the U.S. EPA to schedule meetings with the local communities. The meeting will include representatives from the local, state, and federal agencies who are involved with the GWTP. The contractor-prepared addendum to the ERCP will specify the meeting time, place, and attendees.

RAA/APE/jmf/TMK/RAA/rhs/TMK/jmf/TAL/LMO/jmf
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Table 1-1
Estimated Flows and Scheduling to the Treatment System
American Chemical Services NPL Site,
Griffith, Indiana

Stage	Operating Period ¹	Flow					
		PGCS	SBP	OFCA/K-P	Off-Site	On-Site	Total
		(gpm)	ISVE	ISVE	BWES	BWES	
		Range	Range	Range	Range	Range	Range
1 Off-Site Area Dewatering	Start-up to 1 year	5 - 10	0 - 0	3 - 8.5	22.5 - 28.5	6 - 12	36.5 - 59
2 On-Site Area Dewatering	1 year to 1 year, 8 mo.	5 - 10	0 - 0	3 - 8.5	3.5 - 9.5	27 - 33	38.5 - 61
3 Maintenance Dewatering	1 year, 8 mo. +	5 - 10	0.2 - 5	3 - 8.5	3.5 - 9.5	6.1 - 17	17.8 - 50

Notes:

1. The duration of these operating periods is subject to the implementation schedule of the Final Remedy components.
2. The estimated influent flowrates from the Off-Site and On-Site BWES trenches contain a design factor of safety. Actual influent flowrates from these sources is expected to vary.

Table 1-2
Design Influent Concentrations
American Chemical Services NPL Site,
Griffith, Indiana

Constituents	Units	Influent into	Influent into
		T-101 ¹	T-102 ²
Flow			
Flow rate	gpm	30	60
Water Quality			
pH	Std Unit	7.0	7.0
Residue, susp (TSS)	mg/l	17,000	340
BOD	mg/l	33,000	5,600
COD	mg/l	120,000	21,000
Oil and grease	mg/l	90,000	110
Anions			
Nitrogen, TKN	mg/l as N	10	10
Phosphorus, total	mg/l as P	0.2	0.2
Cations			
Arsenic	mg/l	0.03	0.5
Cadmium	mg/l	0.5	0.2
Calcium	mg/l		78
Chromium, total	mg/l	1.1	0.01
Copper	mg/l	0.3	0.01
Iron	mg/l	1,400	570
Lead	mg/l	2	0.01
Magnesium	mg/l	16	16
Manganese	mg/l	46	46
Mercury	mg/l	0.003	0.003
Nickel	mg/l	0.5	0.1
Potassium	mg/l	6	6
Selenium	mg/l	0.004	0.004
Sodium	mg/l	56	56
Thallium	mg/l	0.2	0.2
Zinc	mg/l	150	44
Regulated Organics ³			
Acetone	µg/l	11,000	11,000
Benzene	µg/l	86,000	14,000
bis(2-Chloroethyl)ether	µg/l	160	160
bis(2-Ethylhexyl)phthalate	µg/l	10,000	57
2-Butanone	µg/l	15,000	14,000
1,2-Dichloroethene-cis	µg/l	9,600	9,600
Ethylbenzene	µg/l	180,000	1,300
Isophorone	µg/l	19,000	830
Methylene Chloride	µg/l	51,000	17,000
4-Methyl-2-pentanone	µg/l	14,000	11,000
4-Methylphenol	µg/l	5,000	5,000
Tetrachloroethene	µg/l	23,000	160
Trichloroethene	µg/l	21,000	470
Vinyl chloride	µg/l	2,700	2,700
Total Organics ³	µg/l	25,436,489	115,780

Notes:

1. Referred to as Pretreatment System Influent during the design process. These concentrations are based on influent estimates from the ISVE condensate pumps and BWES wells containing free product and higher contamination levels.
2. Referred to as Main Treatment System Influent during the design process. These concentrations are based on influent estimates from the PGCS, BWES wells containing lower levels of contamination, and the effluent from ME-1.
3. Organics that are subject to effluent discharge limits.

Table 1-3
Effluent Discharge Limits
American Chemical Services NPL Site,
Griffith, Indiana

Groundwater Quality Parameter	Effluent Standard (Limit)
General Water Quality Parameters	
BOD-5	30 mg/L
TSS	30 mg/L
pH	6 - 9 S.U.
Inorganics	
Arsenic	50 µg/L
Cadmium	4.1 µg/L
Mercury	0.02 µg/L (w/MDL = 0.64) ¹
Selenium	8.2 µg/L
Zinc	411 µg/L
Volatile Organics	
Acetone	6,800 µg/L
Benzene	5 µg/L
2-Butanone	210 µg/L
1,2 - Dichloroethene - cis	70 µg/L
Ethylbenzene	34 µg/L
Methylene chloride	5 µg/L
Tetrachloroethene	5 µg/L
Trichloroethene	5 µg/L
Vinyl chloride	2 µg/L
4 - Methyl - 2 - pentanone	15 µg/L
Semi-Volatile Organics	
bis(2 - Chloroethyl) ether	9.6 µg/L
bis(2 - Ethylhexyl) phthalate	6 µg/L
Isophorone	50 µg/L
4 - Methylphenol	34 µg/L
Pentachlorophenol	1 µg/L
PCBs	
PCBs	0.00056 µg/L (w/MDL = 0.1 to 0.9) ¹

Notes:

1. Concentration shown is the effluent limitation, but analytical results showing less than the method detection limit (MDL) shown will be considered as in compliance. The MDL for PCBs is different for each isomer.

Table 2-1
Anticipated Loadings through Treatment System
American Chemical Services NPL Site,
Griffith, Indiana

ID	Description		Flow ¹ (gpm)	Air Flow (cfm)	pH (S.U.)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	Oil & Grease (mg/L)	Organics (mg/L)	Metals (mg/L)
	High-strength Pretreatment System Influent		30.0	-	7.0	32,657	124,173	17,245	90,217	25,421	1,532
T-101	Gravity Phase Separator	Influent	30.0	-	7.0	32,657	124,173	17,245	90,217	25,421	1,532
		Removal	-7.4	-	NA ²	56.5%	56.5%	95.8%	99.7%	99.9%	-1.9%
		Effluent	22.6	-	7.0	14,199	53,988	723	294	37	1,562
T-103	Pretreatment System Mixing Tank	Influent	22.6	-	7.0	14,199	53,988	723	294	37	1,562
		Removal	0.0	-	-3.0	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
		Effluent	22.6	-	4.0	14,187	53,943	722	293	37	1,560
ME-1	CPI Oil/water Separator	Influent	22.6	-	4.0	14,187	53,943	722	293	37	1,560
		Removal	0.0	-	NA	0.0%	0.0%	0.0%	99.0%	0.0%	0.0%
		Effluent	22.6	-	4.0	14,192	53,961	723	3	37	1,561
T-102	Aerated Equalization Tank ³	Influent	52.6	400	4.4	6,400	24,217	386	131	119	937
		Removal	6.2	-	4.1	55.3%	77.6%	-356.3%	10.6%	89.1%	99.9%
		Effluent	58.8	400	8.5	2,861	5,413	1,763	117	13	ND ⁴
ME-6	Lamella Clarifier	Influent	58.8	-	8.5	2,861	5,413	1,763	117	13	ND
		Removal	-2.8	-	NA	5.6%	10.8%	99.1%	5.6%	-4.9%	NA
		Effluent	56.0	-	8.5	2,702	4,828	15	111	14	ND
ME-101	Activated Sludge Plant	Influent	64.8	2,000	8.5	2,338	4,178	57	96	12	ND
		Removal	-4.2	-	NA	98.7%	98.9%	19.9%	35.8%	99.9%	NA
		Effluent	60.6	2,000	8.5	30	45	46	61	ND	ND
ME-7	Sand Filter	Influent	60.6	-	8.5	30	45	46	61	ND	ND
		Removal	-5.0	-	NA	-9.0%	-9.0%	99.9%	45.6%	NA	NA
		Effluent	55.6	-	8.5	33	49	ND	33	ND	ND
ME-2	UV-Oxidation Unit	Influent	55.6	-	8.5	33	49	ND	33	ND	ND
		Removal	0.0	-	NA	0.0%	0.0%	NA	0.0%	NA	NA
		Effluent	55.6	-	8.5	33	49	ND	33	ND	ND

Table 2-1
Anticipated Loadings through Treatment System
American Chemical Services NPL Site,
Griffith, Indiana

ID	Description		Flow ¹ (gpm)	Air Flow (cfm)	pH (S.U.)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	Oil & Grease (mg/L)	Organics (mg/L)	Metals (mg/L)
ME-8/ME-9	1,500 lb. Sand Filter Beds #1 and #2	Influent	55.6	-	8.5	33	49	ND	33	ND	ND
		Removal	0.0	-	NA	50.0%	50.2%	NA	49.8%	NA	NA
		Effluent	55.6	-	8.5	16	24	ND	17	ND	ND
ME-33	10,000 lb. GAC Unit #1	Influent	55.6	-	8.5	16	24	ND	17	ND	ND
		Removal	0.0	-	NA	67.9%	67.9%	NA	65.2%	NA	NA
		Effluent	55.6	-	8.5	5	8	ND	6	ND	ND
ME-34	10,000 lb. GAC Unit #2	Influent	55.6	-	8.5	5	8	ND	6	ND	ND
		Removal	0.0	-	NA	68.6%	67.3%	NA	64.1%	NA	NA
		Effluent	55.6	-	8.5	2	3	ND	2	ND	ND
	Effluent pH Adjustment System	Influent	55.6	-	8.5	ND	ND	ND	ND	ND	ND
		Removal	0.0	-	-0.5	0%	0%	0%	0%	0%	0.0%
		Effluent	55.6	-	8.0	ND	ND	ND	ND	ND	ND
	Discharge to Wetlands	Effluent	55.6	-	8.0	ND	ND	ND	ND	ND	ND

General Note:

The flowrates and contaminant concentrations in this table are based on the flow and mass balance calculations conducted during design of the GWTP upgrades. These calculations are based on the maximum design influent loading. Flowrates and contaminant concentrations observed during operation of the GWTP may vary based on actual conditions. This table is designed to give the operator a summary of contaminant removal throughout the system and serve as a quick reference during troubleshooting.

Specific Notes:

1. The flowrate into a component may not equal the flowrate out of the same component due to the addition of chemicals (acid, caustic, defoamer, etc.) or the removal of some of the groundwater constituents (TSS, oil & grease, etc.). Also, the concentrations of some compounds may increase or decrease due to changes in flowrate and not due to removal of the actual contaminant. However, in these cases, that mass of the contaminant does not change.
2. Negative numbers indicate a zero percent removal efficiency with respect to mass. However, the concentrations will increase due to a decrease in effluent water (i.e. - water is removed and recycled, etc.)
3. NA = insignificant or no change
4. The influent to T-102 varies from the effluent of ME-1 due to the addition of the PGCS and remaining BWES influent prior to entering T-102. The increase in TSS is due to the metals oxidizing and being considered as TSS.
5. ND = non-detect. The concentration is expected to be below a level that is typically detected by laboratory analysis.

Table 2-2
Summary of Influent Sources
American Chemical Services NPL Site,
Griffith, Indiana

Group ID ²	Description	Extraction Points
1 ¹	ISVE Condensate from SBP Area ISVE System	SBP Area ISVE Knockout Tank
2 ¹	ISVE Condensate from OFCA and K-P Area ISVE Systems	OFCA ISVE Knockout Tank
3	Groundwater from On-Site Extraction Trenches	EW-10, EW-17, EW-18
4	Groundwater from Dual Phase Extraction Wells in SBP Area	SBP Area Extraction Wells
5	Groundwater from Extraction Trenches on East Side of Off-Site Area	EW-15, EW-16, EW-19, EW-19A
6	Groundwater from Extraction Trenches on West Side of Off-Site Area	EW-11, EW-12, EW-13A ³
7	Off-Site Extraction Well (EW-20) and Extraction Wells on the West Side of the Off-Site Area	EW-11, EW-12, EW-20 ³
8	PGCS Extraction System	PGCS Wells

Notes:

1. The ISVE influent lines are not completed at the time that this manual was developed and are considered future modifications to the GWTP.
2. The Group ID number corresponds to the order that the pipes enter the building from North to South, except the PGCS influent (No. 8) which enters the building along the west wall.
3. Extraction Wells EW-11, EW-12, and EW-13 will be valved to discharge to either Source #6 or #7 depending on either hydraulic or contaminant loadings.

Table 3-1
Equipment Index - Tanks
American Chemical Services NPL Site,
Griffith, Indiana

ID	Use	Volume	Material	Manufacturer	Vendor	Contact	Reference
T-1	Decant/Sand Filter Reject Holding Tank	3,500 gal	Stainless Steel	Imperial Industries	Imperial Industries	Name: Jeff Peura Phone: (715) 355-5349	NA
T-2	Activated Sludge Plant Influent Tank	5,800 gal	Stainless Steel	Imperial Industries	Imperial Industries	Name: Jeff Peura Phone: (715) 355-5349	NA
T-3	Sand Filter Effluent Holding Tank	3,500 gal	Stainless Steel	Imperial Industries	Imperial Industries	Name: Jeff Peura Phone: (715) 355-5349	NA
T-4	Filtrate/Decant Holding Tank	1,070 gal	Stainless Steel	Imperial Industries	Imperial Industries	Name: Jeff Peura Phone: (715) 355-5349	NA
T-5	Inorganic Sludge Storage/Thickening Tank	8,900 gal	Carbon Steel	Imperial Industries	Imperial Industries	Name: Jeff Peura Phone: (715) 355-5349	NA
T-6	Oil/NAPL Storage Tank	5,800 gal	Stainless Steel	Imperial Industries	Imperial Industries	Name: Jeff Peura Phone: (715) 355-5349	NA
T-7	CAT-OX Blowdown Holding Tank	7300 gal	Stainless Steel	Kennedy Tank	Bowen Engineering	Name: Jim Ankrum Phone: (317) 842-2616	NA
T-8	Caustic Storage Tank	2500 gal	XLPE	RimCorr	RimCorr	Name: Rich Rimbach Phone: (801) 299-8416	Vol. 7
T-9	Acid Storage Tank	2500 gal	XLPE	RimCorr	RimCorr	Name: Rich Rimbach Phone: (801) 299-8416	Vol. 7
T-12	Precoat Mixing Tank	500 gal	Fiberglass	Unknown	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 6
T-101	Gravity Phase Separation Tank	38,000 gal	Stainless Steel	International Tank Service	Furo-Tech, Inc	Name: Bill Harrington Phone: (219) 963-3123	Vol. 4A
T-102	Aerated Equalization Tank	36,000 gal	Carbon Steel	Furo-Tech, Inc	Furo-Tech, Inc	Name: Bill Harrington Phone: (219) 963-3123	Vol. 4A
T-103	Pretreatment Mixing Tank	500 gal	Stainless Steel	Furo-Tech, Inc	Furo-Tech, Inc	Name: Bill Harrington Phone: (219) 963-3123	Vol. 4A
T-104	Organic Sludge Thickening Tank	8,900 gal	Carbon Steel	Imperial Industries	Imperial Industries	Name: Jeff Peura Phone: (715) 355-5349	Vol. 4A
T-105	Sandfilter Backwash Pumping Tank	130 gal	HDPE	NA	NA	NA	NA

Table 3-1
Equipment Index - Pumps
American Chemical Services NPL Site,
Griffith, Indiana

ID	Use	Capacity	Manufacturer	Model	Vendor	Contact	Reference
P-1	Pump for T-1 Effluent	Type: Centrifugal Motor: 1 hp Rate: 15 gpm @ 56 ft. TDH	Corcoran	2000D	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-2	Pump for T-1 Effluent	Type: Centrifugal Motor: 1 hp Rate: 15 gpm @ 56 ft. TDH	Corcoran	2000D	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-3	Pump for T-2 Effluent	Type: VFD Centrifugal Motor: 2 hp Rate: 30 gpm @ 96 ft TDH	Corcoran	3000D	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-4	Pump for T-2 Effluent	Type: VFD Centrifugal Motor: 2 hp Rate: 30 gpm @ 96 ft TDH	Corcoran	3000D	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-5	Pump for T-2 Effluent	Type: VFD Centrifugal Motor: 2 hp Rate: 30 gpm @ 96 ft TDH	Corcoran	3000D	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-6	Pump for T-3 Effluent	Type: VFD Centrifugal Motor: 2 hp Rate: 30 gpm @ 96 ft TDH	Aurora	Series 321	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-7	Pump for T-3 Effluent	Type: VFD Centrifugal Motor: 2 hp Rate: 30 gpm @ 96 ft TDH	Aurora	Series 321	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-8	Pump for T-3 Effluent	Type: VFD Centrifugal Motor: 2 hp Rate: 30 gpm @ 96 ft TDH	Aurora	Series 321	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-9	Pump for T-4 Effluent	Type: Centrifugal Motor: 3/4 hp Rate: 30 gpm @ 34 ft TDH	Corcoran	2000D	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-10	Pump for T-4 Effluent	Type: Centrifugal Motor: 3/4 hp Rate: 30 gpm @ 34 ft TDH	Corcoran	2000D	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-11	Filter Press Area Sump Pump	Type: Submersible ¹ Rate: 16 gpm					
P-12	Sludge Pump for ME-1	Type: ADDP ² Rate: 100 gpm @ 120 psig	ARO	6661T4-844	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-13	Sludge Pump for ME-6	Type: ADDP Rate: 100 gpm @ 120 psig	ARO	6661T4-844	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-14	Sludge Pump for T-5	Type: ADDP Rate: 125 gpm	ARO	P030A-AAP-GGG	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-16	Standby Peroxide Feed Pump for ME-6 (Not Used)	Type: Metering ³ Rate: 1.5 gph @ 145 psig	ProMinent Fluid Controls	Gamma/5 G/5A	Solarchem	Name: NA Phone: (519) 836-5698	Vol. 7
P-17	Standby Acid Feed Pump for ME-6 (Not Used)	Type: Metering Rate: 1.5 gph @ 145 psig	ProMinent Fluid Controls	Gamma/5 G/5B	Solarchem	Name: NA Phone: (519) 836-5698	Vol. 7
P-18	Acid Feed Pump for T-103	Type: Metering Rate: 3.3 gph @ 100 psig	Jaeco	Series E Model EC-080-1H-EA-PH-VS	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-19	Acid Feed Pump for T-3	Type: Metering Rate: 3.3 gph @ 100 psig	Pulsatron	LPA2MA-VTC1-V03	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-20	Acid Feed Pump for Effluent	Type: Metering Rate: 3.3 gph @ 100 psig	Jaeco	Series E Model EC-080-1H-EA-PH-VS	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7

Table 3-1
Equipment Index - Pumps
American Chemical Services NPL Site,
Griffith, Indiana

ID	Use	Capacity	Manufacturer	Model	Vendor	Contact	Reference
P-21	Caustic Feed Pump for T-3	Type: Metering Rate: 3.3 gph @ 100 psig	Pulsatron	LPA2MA-VTC1-V03	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-22	Caustic Feed Pump for Effluent	Type: Metering Rate: 3.3 gph @ 100 psig	Jaeco	Series E Model EC-080-1H-EA	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
P-24	Standby Enox Feed Pump for ME-6 (Not Used)	Type: Metering Rate: 0.57 gph @ 145 psig	ProMinent Fluid Controls	Gamma/4 G/4A	Solarchem	Name: NA Phone: (519) 836-5698	Vol. 7
P-25	Polymer Feed pump for ME-6	Type: Blending, Pacing ⁴	Stranco	Polyblend PB16-1	Stranco	Name: NA Phone: (800) 882-6466	Vol. 7
P-26	Standby Caustic Feed Pump for ME-6	Type: Metering Rate: 1.5 gph @ 145 psig	ProMinent Fluid Controls	Gamma/5 G/5A	Solarchem	Name: NA Phone: (519) 836-5698	Vol. 7
P-32	Precoat Feed Pump	Type: ADDP Rate: 25 gpm	Wildon	W50	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	NA
P-101	Sludge Pump for T-101	Type: ADDP Rate: 100 gpm @ 90 ft TDH	ARO	Model 666151-244-C 1 1/2" SS	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-102	Sludge Pump for ME-101	Type: ADDP Rate: 100 gpm @ 75 ft TDH	ARO	Model 666151-244-C 1 1/2" SS	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-104	Pump for T-102 Effluent	Type: VFD Centrifugal Motor: 1.5 HP Rate: 60 gpm @ 40 ft TDH	Ingersoll Dressor	Model 1 1/2" x 1" x 5" SMP	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-105	Pump for T-102 Effluent	Type: VFD Centrifugal Motor: 1.5 HP Rate: 60 gpm @ 40 ft TDH	Ingersoll Dressor	Model 1 1/2" x 1" x 5" SMP	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-106	South Sump Pump	Type: Submersible Motor: 0.33 HP	Ebara	EPPD3ASI	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-107	Pacing Feed Pump for De-emulsifier	Type: Blending, Pacing ⁴ Controller: RED-ID Rate: 2.0 gph @ 50 psig	U.S. Filter/Stranco	Polyblend PB100-2	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-108A	Feed Pump for Defoamer (ME-101 Bio Tank)	Type: Metering Rate: 94 gpd @ 100 psig	Jaeco	EC-094-1H	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
P-108B	Feed Pump for Defoamer (T-102 Aeration Tank)	Type: Metering Rate: 60 gpd @ 150 psig	Pulsatron	LPK5MA-PTC3-XXX	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
P-109	Caustic Feed Pump for ME-4	Type: Metering Rate: 8 gph @ 60 psig	LMI	Liquipro C931-26S	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-110	Nutrient (Nitrogen) Feed Pump for ME-101	Type: Metering Rate: 4.0 gph @ 100 psig	LMI	C921-363BI	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-111	Nutrient (Phosphorous) Feed Pump for ME-101	Type: Metering Rate: 2.5 gph @ 100 psig	LMI	Liquipro B921-925	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
P-112	Sump Pump for Outside Secondary Containment System	Type: Submersible Motor: 0.4 HP	Hydraulic Pumps	SHEF40A2	J.W. Wilson & Associates	Name: NA Phone: (219) 663-1076	Vol. 9
SP-10A	North Sump Pump	Type: Submersible, 3hp	Flygt	Z-75V	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 6
SP-10B	Middle Sump Pump	Type: Submersible, 3hp	Flygt	Z-75V	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 6
EP-19	PGCS Extraction Pump	Type: Elect. Submersible ⁵ Rate: 16 gpm @ 100 ft TDH	Grundfos	16S	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 6
EP-20	PGCS Extraction Pump	Type: Elect. Submersible ⁵ Rate: 16 gpm @ 100 ft TDH	Grundfos	16S	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 6

Table 3-1
Equipment Index - Pumps
American Chemical Services NPL Site,
Griffith, Indiana

ID	Use	Capacity	Manufacturer	Model	Vendor	Contact	Reference
EP-21	PGCS Extraction Pump	Type: Elect. Submersible ⁵ Rate: 16 gpm @ 100 ft TDH	Grundfos	16S	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 6
PP-10	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
PP-11	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
PP-12	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
PP-13	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
PP-15	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
PP-16	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
PP-18	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
PP-19	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9
PP-20	BWES Extraction Pump w/ Electric Motor	Type: Elect. Submersible ⁶ Rate: 20 gpm @ 230V single phase	Sta-Rite Signature 2000 pump Franklin electric motor	pump: 7SP4CO2HL-04 motor: 2445059004, 1/2 hp	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol. 9

Notes:

1. Submersible pump with internal float switch.
2. ADDP = Air double diaphragm pump.
3. Metering pumps are solenoid-driven diaphragm pumps.
4. Mixes and paces pumping of neat product/water mixture.
5. Electrically-driven submersible well pump with external on/off switch.
6. Electrically-driven submersible well pump controlled by local "motor minder" control panel.

Table 3-1
Equipment Index - Mechanical Equipment
American Chemical Services NPL Site,
Griffith, Indiana

ID	Description	Capacities	Manufacturer	Model	Vendor	Contact	Reference
ME-1	CPI Oil/Water Separator	Flow: 30 gpm Media Area: 672 SF Material: 316 S.S.	Eaprotec	J5001-31	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 7
ME-2	Ultraviolet-Oxidation Unit	Flow: 10-60 gpm Lamp: 60 kW	Calgon Carbon	30 kW Rayox	Solarchem	Name: Martin Crawford Phone: (707) 435-9390	Vol. 8
ME-3	Standby Mixer for UV-OX Influent	Size: 2" S.S. Flow: 27-60 gpm	Komax	34091	Solarchem	Name: Martin Crawford Phone: (707) 435-9390	NA
ME-4	Rapid Mix Tank for Lamella Clarifier	Max. Flow: 60 gpm Mix Time: 0.78 min.	Parkson	15" x 15" x 4'	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 7
ME-5	Flocculation Mix Tank for Lamella Clarifier	Max. Flow: 60 gpm Mix Time: 4.5 min.	Parkson	3' x 3' x 4'	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 7
ME-6	Lamella Clarifier	Max. Flow: 145 gpm Settling Area: 360 SF Sludge Storage: 2,000 gal.	Parkson	360/55	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 7
ME-7	Sand Filter	Max. Flow: 96 gpm Filtration Area: 12 SF Bed Depth: 40 inches Reject Rate: 28 gpm	Parkson	DynaSand Filter Model 12 DBTF/I	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 7
ME-8	1,500-lb Sand Filter Bed Unit	Max. Flow: 50 gpm Media Qty: 1,500 lb.	Wheelabrator Water Tech./ Westates Carbon Products	Aqua-Scrub PV-50-2-K6401	Wheelabrator Water Tech./ Westates Carbon Products	Name: Christopher Rinaldi Phone: (908) 776-3344	Vol. 7
ME-9	1,500-lb Sand Filter Bed Unit	Max. Flow: 50 gpm Media Qty: 1,500 lb.	Wheelabrator Water Tech./ Westates Carbon Products	Aqua-Scrub PV-50-2-K6401	Wheelabrator Water Tech./ Westates Carbon Products	Name: Christopher Rinaldi Phone: (908) 776-3344	Vol. 7
ME-12	Filter Press	Capacity: 30 CF No. of Plates: 24	JWI	1200G32-24-30SYLS	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 6
ME-14	Roll-Off Dumpster for ME-12	Capacity: 20 CY	Mac Corp.	20 CY Roll Off	Illiana Disposal & Recycling	Name: NA Phone: (800) 865-3078	NA
ME-15	Standby Mixer for T-1	Type: 3 Blade Motor: 2.0 hp, 1750 rpm	Brawn Mixer	BGMF200-350/LP	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
ME-16	Standby Mixer for T-2	Type: 4 Blade Motor: 1.5 hp, 1725 rpm	Brawn Mixer	BTO150-70/LP	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (847) 882-8116	Vol. 7
ME-17	Mixer for ME-4	Type: 3 Blade Motor: 0.5 hp, 1800 rpm	Nord/Parkson	SK1282 AZH-71L4 w/ taper bearings	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 7
ME-18	Mixer for ME-5	Type: Paddle Motor: 0.5 hp, 1800 rpm	Nord/Parkson	SK02050 AZSH-RV10-56C	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 7
ME-19	Sludge Rake for ME-6	Type: Picket Fence Motor: 0.24 hp, 1800 rpm	Nord/Parkson	SK3282/12AZSH-RV10-56C	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	Vol. 7
ME-20	Standby Mixer for T-3	Type: 3 Blade Motor: 2.0 hp, 1750 rpm	Brawn Mixer	BGMF200-350/LP	Pumps and Process Equipment, Inc.	Name: Sean Hudson Phone: (317) 842-2616	Vol. 7
ME-22	Standby Mixer for T-5	Type: Dual 4 Blade Motor: 5.0 hp, 1725 rpm	Brawn Mixer	BTO500-70/LP	Pumps and Process Equipment, Inc.	Name: Jim Ankrum Phone: (317) 842-2616	Vol. 7
ME-23	Polymer Blend Unit for Lamella Clarifier	Max. Water: 16 gph Max. Polymer: 1gph	Stranco	Polyblend PB16-1	Stranco	Name: NA Phone: (800) 882-6466	Vol. 7
ME-24	Air Compressor, Air Dryer, and Receivers	Air Capacity: 102 SCFM Max. Pressure: 100 psig	AC: Quincy AD: Pneumatech	AC: QRD-150-240 duplex AD: PHM-50	Cochrane	Name: Robert Barnes Phone: (708) 345-0225	Vol. 7 Vol. 6

Table 3-1
Equipment Index - Mechanical Equipment
American Chemical Services NPL Site,
Griffith, Indiana

ID	Description	Capacities	Manufacturer	Model	Vendor	Contact	Reference
ME-26	Vapor Phase Carbon Canister	Max. Air Flow: 6 cfm Carbon Qty.: 55 gal. Drum	Wheelabrator Water Tech./ Westates Carbon Products	Vent Scrub VSC-200	Wheelabrator Water Tech./ Westates Carbon Products	Name: Christopher Rinaldi Phone: (908) 776-3344	NA
ME-32	Mixer for T-12	Type: 3 Blade Motor: 0.33 hp, 1725 rpm	Chemineer	5JTC-0.33	Dryden Equipment	Name: Robert Woodridge Phone: (847) 228-7878	NA
ME-33	10,000-lb GAC Unit	10,000 lb	Carbonair	Decon 3	Carbonair	Name: Bill Hauck Phone: (800) 526-4999	Vol. 6
ME-34	10,000-lb GAC Unit	10,000 lb	Carbonair	Decon 3	Carbonair	Name: Bill Hauck Phone: (800) 526-4999	Vol. 6
ME-101	Activated Sludge Plant	Flow: 17.5 - 60 gpm BOD: 500 - 3,500 mg/L MLSS: 2,000 - 4,000 mg/L Size: Dia = 56.5 ft, H = 24 ft Clarifier Dia.: 20 ft, 8 in	Smith & Loveless	Model R SN: 41-0641-S	Gasvoda & Assoc. Smith & Loveless	Name: Dan Tomich Phone: (708) 891-5201 Name: Janet Strickland Phone: (913) 888-5201 S&L Parts: (800) 922-9048	Vol. 10
ME-102	Activated Sludge Plant Blower	Type: Positive Displacement Air Flow: 1050 SCFM Motor: 100 hp Pressure: 12 psi	Roots	P-616RAM-100-6F	Powered Equipment & Repair Smith & Loveless	Name: Service Dept. Phone: (812) 232-2421 Name: Don Aholt Phone: (913) 888-5201	Vol. 10
ME-103	Activated Sludge Plant Blower	Type: Positive Displacement Air Flow: 1050 SCFM Motor: 100 hp Pressure: 12 psi	Roots	P-616RAM-100-6F	Powered Equipment & Repsir Smith & Loveless	Name: Service Dept. Phone: (812) 232-2421 Name: Janet Strickland Phone: (913) 888-5201	Vol. 10
ME-104	Activated Sludge Plant Back-up Blower	Type: Positive Displacement Air Flow: 400 SCFM Motor: 30 hp Pressure: 10 psi	Roots	FS 30 N3-R68	Fliteway Technologies	Name: William Diehl Phone: (800) 236-3580	Vol. 9
ME-105	Equalization/Aeration Tank Blower	Type: Positive Displacement Air Flow: 400 SCFM Motor: 30 hp Pressure: 10 psi	Roots	FS 30 N3-R68	Fliteway Technologies	Name: Service Dept. Phone: (800) 236-3580	Vol. 9
ME-106	Catalytic Oxidizer and Scrubber	Air Flow: 400 SCFM DRE: 95%	Catalytic Combustion	CAT-OX: HD500G Scrubber: Series 400 CC#: 99-417	Catalytic Combustion	Name: Gary Unke Phone: (715) 568-2882	Vol. 10
ME-109	Mixer for T-103	Type: 3 Blade Motor: 0.33 hp, 1725 rpm	Chemineer	C4C17FC98	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9
ME-110	Static Mixer for Effluent	Size: 2" CPVC Flow: 27-60 gpm	Komax	34091	Ryan Construction	Name: Doug Gough Phone: (219) 756-7417	Vol. 9

Table 3-1
Equipment Index - Control Equipment
American Chemical Services NPL Site,
Griffith, Indiana

ID	Location	Description	Manufacturer	Model	Vendor	Contact	Reference
CE-3	pH Sensor for Tank T-3	Type: Submersion Material: LCP Acc.: Self Cleaner	Rosemont Analytical	3081-81 (sensor)	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
CIC-3	pH Controller for Tank T-3	Range: 0 to 14 S.U. Outputs: (2) 4-20 mA, (3) relays	Rosemont Analytical	3081-81 (controller)	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
CE-102	pH Sensor for Lamella Clarifier	Type: Submersion Material: LCP Acc.: Self Cleaner	Great Lakes Instruments	6028P020	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
CIC-102	pH Controller for Lamella Clarifier	Range: 0 to 14 S.U. Outputs: (2) 4-20 mA, (3) relays	Great Lakes Instruments	P63AIAIAIAI-NNS	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
CE-103	pH Sensor for T-103	Type: Submersion Material: LCP Acc.: Self Cleaner	Great Lakes Instruments	6028P020	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
CIC-103	pH Controller for T-103	Range: 0 to 14 S.U. Outputs: (2) 4-20 mA, (3) relays	Great Lakes Instruments	P63AIAIAIAI-NNS	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
CE-110	pH Sensor for Effluent pH Adjustment System	Type: Insert Material: CPVC	Signet +GF+	2714	KTH Sales	Name: Vince Walding Phone: (219) 736-0060	NA
CIC-110	pH Controller for Effluent pH Adjustment System	Range: 0 to 14 S.U.	Signet +GF+	8720	KTH Sales	Name: Vince Walding Phone: (219) 736-0060	NA
DM-101	Turbidity Sensor	Type: Insertion Range: 1-2000 ppm	Great Lakes Instruments	Model 7530SSN-E	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
DIC-101	Turbidity Solids Analyzer	Display: ppm or NTU Output: (1) 4-20mA, (5) relays	Great Lakes Instruments	Model 7110MTF-FG	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
FM-101/ FM/FIT-101	Flow Meter/Transmitter for EW-10, EW-17, & EW-18, Drum Pad	Type: Turbine Housing: 1.5" Dia, S.S. Flow: 5-100 gpm	ABB Water Meters, Inc.	S150	Simco Controls	Name: NA Phone: (317) 577-0982	Vol: 9
FM-102/ FIT-102	Flow Meter/Transmitter for SBP Extraction Wells	Type: Turbine Housing: 2" Dia, S.S. Flow: 10-200 gpm	ABB Water Meters, Inc.	S200	Simco Controls	Name: NA Phone: (317) 577-0982	Vol: 9
FM-103/ FIT-103	Flow Meter/Transmitter for EW-11, EW-12, & EW-13A	Type: Turbine Housing: 1.5" Dia, S.S. Flow: 5-100 gpm	ABB Water Meters, Inc.	S150	Simco Controls	Name: NA Phone: (317) 577-0982	Vol: 9
FM-104/ FIT-104	Flow Meter/Transmitter for EW-11, EW-13A, & EW-20	Type: Turbine Housing: 1.5" Dia, S.S. Flow: 5-100 gpm	ABB Water Meters, Inc.	S150	Simco Controls	Name: NA Phone: (317) 577-0982	Vol: 9
FM-105/ FIT-105	Flow Meter/Transmitter for EW-15, EW-16, & EW-19	Type: Turbine Housing: 1.5" Dia, S.S. Flow: 5-100 gpm	ABB Water Meters, Inc.	S150	Simco Controls	Name: NA Phone: (317) 577-0982	Vol: 9
FM-106/ FIT-106	Flow Meter/Transmitter for OFCA ISVE Condensate	Type: Turbine Housing: 1.5" Dia, S.S. Flow: 5-100 gpm	ABB Water Meters, Inc.	S150	Simco Controls	Name: NA Phone: (317) 577-0982	Vol: 9

Table 3-1
Equipment Index - Control Equipment
American Chemical Services NPL Site,
Griffith, Indiana

ID	Location	Description	Manufacturer	Model	Vendor	Contact	Reference
FM-107/ FIT-107	Flow Meter/Transmitter for SBP ISVE Condensate	Type: Turbine Housing: 1.5" Dia, S.S. Flow: 5-100 gpm	ABB Water Meters, Inc.	S150	Simco Controls	Name: NA Phone: (317) 577-0982	Vol: 9
FM-108/ FIT-108	Flow Meter/Transmitter for T-101 Influent	Type: Turbine Housing: 2" Dia, S.S. Flow: 10-200 gpm	ABB Water Meters, Inc.	S200	Simco Controls	Name: NA Phone: (317) 577-0982	
FM-109/ FIT-109	Flow Meter/Transmitter for Combined "Clean" Flow	Type: Turbine Housing: 2" Dia, S.S. Flow: 10-200 gpm	ABB Water Meters, Inc.	S200	Simco Controls	Name: NA Phone: (317) 577-0982	Vol: 9
FM/FIT-801	Effluent Flow Meter/Transmitter	Type: Magnetic	Bailey, Fischer & Porter	10D1475Y	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
FM/FIT-802	PGCS Influent Flow Meter/Transmitter	Type: Magnetic	Bailey, Fischer & Porter	10D1475Y	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
FM/FIT-803	Flow Meter/Transmitter for T-102 Effluent	Type: Magnetic	Bailey, Fischer & Porter	10D1475Y	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
PE/PIT-24	Pressure Element for Air Compressor ME-24	Range: 0 - 800 psi Output: 4-20 mA	Rosemont	G3S22A1M5	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
PE/PIT-201	Pressure Element for Sand Filter Bed Influent	Range: 0 - 150 psi Output: 4-20 mA	Rosemont	G2S22A1M5	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
PE/PIT-202	Pressure Element for Sand Filter Bed Effluent	Range: 0 - 150 psi Output: 4-20 mA	Rosemont	G2S22A1M5	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
PS-102	Low Pressure Switch For Blowers ME-2, ME-3, & ME-4	Max Air: 2,500 SCFM Max. Press: 25 psig Output: relay	Dwyer Instruments, Inc.	Photohelic Switch/Gage	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
PS-105	Low Pressure Switch For Blower ME-5	Max Air: 2,500 SCFM Max. Press: 25 psig Output: relay	Dwyer Instruments, Inc.	Photohelic Switch/Gage	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
LE/LIT-2	Pressure Transducer/Transmitter for T-2	Type: Pressure Transducer	Moore	XTC Series 340	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LE/LIT-3	Pressure Transducer/Transmitter for T-3	Type: Pressure Transducer	Moore	XTC Series 340	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LE/LIT-102	Level Indicator/Transmitter for T-102	Type: Pressure Transducer	US Filter Control Systems	Serial 307801	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
LSH-1	High Level Switch for T-1	Type: Float Switch	Flotect	L4	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSH-4	High Level Switch for T-4	Type: Float Switch	Flotect	L4	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSH-5	High Level Switch for T-5	Type: Float Switch	Flotect	L4	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSH-6	High Level Switch for T-6	Type: Float Switch	Drexelbrook	Ztron 502-300 Level Control 402-3000 Transmitter	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSH-101	High Level Switch for T-101	Type: Ultrasonic Point Level Switch	Omega	LV-1102 (LVU-700 Series)	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
LSH-104	High Level Switch for T-104	Type: Ultrasonic Point Level Switch	Omega	LVU-701-NO (LVU-700 Series)	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9

Table 3-1
Equipment Index - Control Equipment
American Chemical Services NPL Site,
Griffith, Indiana

ID	Location	Description	Manufacturer	Model	Vendor	Contact	Reference
LSH-106	High Level Switch for South Sump	Type: Ultrasonic Point Level Switch	Omega	LV613-P (LVU-700 Series)	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
LSH-10A	High Level Switch for North Sump	Type: N/O Float	ABS	NA	Grainger	Name: NA Phone: (219) 944-7137	NA
LSH-10B	High Level Switch for Middle Sump	Type: N/O Float	ABS	NA	Grainger	Name: NA Phone: (219) 944-7137	NA
LSHH-1	High-High Level Switch for T-1	Type: Float Switch	Flotect	L4	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSHH-4	High-High Level Switch for T-4	Type: Float Switch	Flotect	L4	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSH-M101	High Level Switch for ME-101	Type: Ultrasonic Point Level Switch	Omega	LVU-701-NO (LVU-700 Series)	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
LSL-1	Low Level Switch for T-1	Type: Float Switch	Static-O-Ring	SOR	NA	Name: NA Phone: (913) 888-2630	Vol: 6
LSL-4	Low Level Switch for T-4	Type: Float Switch	Flotect	L4	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSL-5	Low Level Switch for T-5	Type: Float Switch	Drexelbrook	Ztron 502-300 Level Control 402-3000 Transmitter	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSL-8	Low Level Switch for T-8	Type: Float Switch	Drexelbrook	Ztron 502-300 Level Control 402-3000 Transmitter	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
LSL-9	Low Level Switch for T-9	Type: Float Switch	Drexelbrook	Ztron 502-300 Level Control 402-3000 Transmitter	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 5
SV-101A	Solenoid Valve for ME-101 Effluent	Type: Two-way PVC Valve: Butterfly Size: 4-inch	Hayward	Motor: EV56K Valve: 4"	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-110B	Solenoid Valve for ME-101 Effluent	Type: Two-way PVC Valve: Butterfly Size: 4-inch	Hayward	Motor: EV56K Valve: 4"	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-110A	Solenoid Valve for Effluent pH Adjustment System	Type: Two-way PVC Valve: Butterfly Size: 2-inch	Hayward	Motor: EV53-EK Valve: 1 1/2" - 2"	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-110B	Solenoid Valve for Effluent pH Adjustment System	Type: Two-way PVC Valve: Butterfly Size: 2-inch	Hayward	Motor: EV53-EK Valve: 1 1/2" - 2"	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-P101	Solenoid Valve for Sludge Pump P-101 Control	Type: Two-way Size: 3/4" Pressure: 5-150 PSI Material: SS	Gould	K-3B	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-P102	Solenoid Valve for Sludge Pump P-102 Control	Type: Two-way Size: 3/4" Pressure: 5-150 PSI Material: SS	Gould	K-3B	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-201	Solenoid Valve for Sand Filter Automatic Backwash System	Type: Two-way Size: 2-inch	Hayward	EVR2K	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9

Table 3-1
Equipment Index - Control Equipment
American Chemical Services NPL Site,
Griffith, Indiana

ID	Location	Description	Manufacturer	Model	Vendor	Contact	Reference
SV-202	Solenoid Valve for Sand Filter Automatic Backwash System	Type: Two-way Size: 2-inch	Hayward	EVR2K	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-203	Solenoid Valve for Sand Filter Automatic Backwash System	Type: Two-way Size: 2-inch	Hayward	EVR2K	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-204	Solenoid Valve for Sand Filter Automatic Backwash System	Type: Two-way Size: 2-inch	Hayward	EVR2K	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-205	Solenoid Valve for Sand Filter Automatic Backwash System	Type: Two-way Size: 2-inch	Hayward	EVR2K	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-206	Solenoid Valve for Sand Filter Automatic Backwash System	Type: Two-way Size: 2-inch	Hayward	EVR2K	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9
SV-207	Solenoid Valve for Sand Filter Automatic Backwash System	Type: Two-way Size: 2-inch	Hayward	EVR2K	USA Blue Book	Name: NA Phone: 1-800-548-1234	Vol: 9

Table 4-1
Initial Equipment Set Points
American Chemical Services NPL Site,
Griffith, Indiana

pH Adjustment Systems

Area	Equipment	Signal	Set Point	Action/Description	
Mixing Tank T-103 pH Adjustment System	CIC-103	4 mA	0 S.U.	At	- Calibration set point
		20 mA	14 S.U.	At	- Calibration set point
	P-18	Set Point	4 S.U.	Above	- Activates metering pump P-18
		Gain	8.0	At	- Proportional Gain - based on difference in actual pH from target
		Reset	0.0	At	- Integral Gain - based on the time that the actual pH is different from target
		Rate	0.0	At	- Derivative Gain - based on rate of pH change
	Alarm	High Alarm	7 S.U.	At or Above	- Enables high pH alarm (CAH-103)
		Low Alarm	3 S.U.	At or Below	- Enables low pH alarm (CAL-103)
Lamella Clarifier pH Adjustment System	CIC-102	4 mA	0 S.U.	At	- Calibration set point
		20 mA	14 S.U.	At	- Calibration set point
	P-109	Set Point	8 S.U.	Below	- Activates metering pump P-109
		Gain	4.5	At	- Proportional Gain - based on difference in actual pH from target
		Reset	0.0	At	- Integral Gain - based on the time that the actual pH is different from target
		Rate	0.0	At	- Derivative Gain - based on rate of pH change
	Alarm	High Alarm	9 S.U.	At or Above	- Enables high pH alarm (CAH-102)
		Low Alarm	7 S.U.	At or Below	- Enables low pH alarm (CAL-102)
Final Effluent pH Adjustment System	CIC-110	4 mA	0 S.U.	At	- Calibration set point
		20 mA	14 S.U.	At	- Calibration set point
	P-20/P-22	Set Point	7.5 S.U.	Below	- Activates metering pump P-22
				Above	- Activates metering pump P-20
	Deadband	Range	+/- 1/2 pt. From Set Point		
	Alarm	High Alarm	8.5 S.U.	At or Above	- Enables high pH alarm (CAH-110) - Closes solenoid valve SV-110A and opens solenoid valve SV-110B
		Low Alarm	6.5 S.U.	At or Below	- Enables low pH alarm (CAL-110) - Closes solenoid valve SV-110A and opens solenoid valve SV-110B
pH Adjustment in tank T-3	CIC-3	Set Point	7.0 S.U.	Below	-Activates metering pump P-21
				Above	-Activates metering pump P-19
	Alarm	High Alarm	8.5 S.U.	At or Above	-Enables high pH alarm (CAH-3)
		Low Alarm	2.5 S.U.	At or Below	-Enables low pH alarm (CAL-3)

Level Controllers¹

Area	Controller	Level ID	Set Point ²		Action	
PGCS Extraction pumps			633 feet (USGS scale)		At or Above	- High level alarm activated
			624 feet (USGS scale)		At or Above	- PGCS pump(s) enabled
					Below	- PGCS pump(s) disabled
Aerated Equalization Tank	LE/LIT-102	LL1-102	180 in.	32,300 gal.	Below	- Disables pumps P-104 and P-105
		LH1-102	200 in.	35,900 gal.	Above	- Enables pumps P-104 and/or P-105 until water < LL1-102
		LL2-102	190 in.	34,100 gal.	Below	- Enables PGCS extraction pump EP-19
		LH2-102	202 in.	36,300 gal.	Above	- Disables PGCS extraction pump EP-19 until water level < LL2-102
		LL3-102	190 in.	34,100 gal.	Below	- Enables PGCS extraction pump EP-20
		LH3-102	202 in.	36,300 gal.	Above	- Disables PGCS extraction pump EP-20 until water level < LL3-102
		LL4-102	190 in.	34,100 gal.	Below	- Enables PGCS extraction pump EP-21
		LH4-102	202 in.	36,300 gal.	Above	- Disables PGCS extraction pump EP-21 until water level <LL4-102
		LL5-102	190 in.	34,100 gal.	Below	- Opens SV-24 to enable the On-Site Area BWES pumps
		LH5-102	204 in.	36,600 gal.	Above	- Closes SV-24 to the On-Site Area BWES pump until water level <LL5-102
		LL6-102	192 in.	34,500 gal.	Below	- Enables Off-Site Area BWES pumps
		LH6-102	204 in.	36,600 gal.	Above	- Disables Off-Site Area BWES pumps until water level <LL6-102
		LL7-102	200 in.	35,900 gal.	Below	- Enables ISVE condensate pumps
		LH7-102	206 in.	37,000 gal.	Above	- Disables ISVE condensate pumps until water level < LL7-102
		LL8-102	168 in.	30,100 gal.	Below	- Activates low level alarm (LAL-102) - Removes permissive for recycle pumps P-9 and P-10
		LH8-102	211 in.	38,000 gal.	Above	- Activates high level alarm (LAH-102) - Removes permissive for recycle pumps P-9 and P-10
		4 mA	0.96 ft.		At	- None (Calibration set point for level controller)
		20 mA	21.08 ft.		At	- None (Calibration set point for level controller)
Holding Tank T-2	LE/LIT-2	LT1-2	60 in.	2,380 gal.	At	- Target water level. Pumping rates of VFD pumps P-3, P-4, and P-5 adjusted to maintain this level
		LH1-2	130 in.	5,155 gal.	Above	- Activates high level alarm (LAH-2) - Closes SV-24 to disable the On-Site Area BWES pumps - Disables Off-Site Area BWES pumps - Disables PGCS extraction pumps - Disables ISVE condensate pumps - Disables process pumps P-9, P-10, P-104, and P-105
		LL1-2				- Disables pumps P-3, P-4, and P-5 until water level > LT1-2
		4 mA				- None (Calibration set point for level controller)
		20 mA				- None (Calibration set point for level controller)
		LL1-3	50 in.	1,565 gal.	Below	- Disables pumps P-6, P-7, and P-8 until water level > LT1-3
						- None (Calibration set point for level controller)
Holding Tank T-3	LE/LIT-3	LT1-3	80 in.	3,000 gal.	At	- Target water level. Pumping rates of VFD pumps P-6, P-7, and P-8 adjusted to maintain this level
		LH1-3	96 in.	2,500 gal.	Above	- Activates high level alarm (LAH-2) - Closes SV-24 to disable the On-Site Area BWES pumps - Disables Off-Site Area BWES pumps - Disables PGCS extraction pumps - Disables ISVE condensate pumps - Disables process pumps P-3, P-4, P-5, P-9, P-10, P-104, and P-105
		LL1-3				- Disables pumps P-6, P-7, and P-8 until water level > LT1-3
		4 mA				- None (Calibration set point for level controller)
		20 mA				- None (Calibration set point for level controller)
		LL1-3	50 in.	1,565 gal.	Below	- Disables pumps P-6, P-7, and P-8 until water level > LT1-3
						- None (Calibration set point for level controller)

Table 4-1
Initial Equipment Set Points
American Chemical Services NPL Site,
Griffith, Indiana

Miscellaneous Instrumentation/Control Equipment

Area/Process	Equipment	Signal	Set Point	Action/Description	
Flow Meters	FM/FIT-101	4 mA	0 gpm	At	- Calibration set point
		20 mA	30 gpm	At	- Calibration set point
	FM/FIT-102	4 mA	0 gpm	At	- Calibration set point
		20 mA	30 gpm	At	- Calibration set point
	FM/FIT-103	4 mA	0 gpm	At	- Calibration set point
		20 mA	30 gpm	At	- Calibration set point
	FM/FIT-104	4 mA	0 gpm	At	- Calibration set point
		20 mA	30 gpm	At	- Calibration set point
	FM/FIT-105	4 mA	0 gpm	At	- Calibration set point
		20 mA	30 gpm	At	- Calibration set point
	FM/FIT-106	4 mA	0 gpm	At	- Calibration set point
		20 mA	30 gpm	At	- Calibration set point
	FM/FIT-107	4 mA	0 gpm	At	- Calibration set point
		20 mA	30 gpm	At	- Calibration set point
	FM/FIT-108	4 mA	0 gpm	At	- Calibration set point
		20 mA	50 gpm	At	- Calibration set point
	FM/FIT-109 ³	4 mA	0 gpm	At	- Calibration set point
		20 mA	75 gpm	At	- Calibration set point
	FM/FIT-801	4 mA	0 gpm	At	- Calibration set point
		20 mA	75 gpm	At	- Calibration set point
	FM/FIT-802	4 mA	0 gpm	At	- Calibration set point
		20 mA	75 gpm	At	- Calibration set point
Turbidity Meter	DM/DIC-101	4 mA	0 ppm	At	- Calibration set point
		20 mA	500 ppm	At	- Calibration set point
		High Alarm	100 ppm	Above	- Activates high turbidity alarm (DAH-101)
					- Closes solenoid valve SV-101A and opens solenoid valve SV-101B
Sand Filter Bed Automatic Backwash System ³	PE/PIT-201	4 mA	0 psi	At	- Calibration set point
		20 mA	100 psi	At	- Calibration set point
	PE/PIT-202	4 mA	0 psi	At	- Calibration set point
		20 mA	100 psi	At	- Calibration set point
Catalytic Oxidizer/Scrubber	Set Point	Δ psi	15 psi	At or Above	- Enables automatic backwash system
	Air Flow	4 mA	0 cfm	At	- Calibration set point
		20 mA	500 cfm	At	- Calibration set point
	Inlet Temp.	4 mA	0 °F	At	- Calibration set point
		20 mA	1,500 °F	At	- Calibration set point
	Outlet Temp.	4 mA	0 °F	At	- Calibration set point
		20 mA	1,500 °F	At	- Calibration set point

- Notes:
- 1. Only level controllers with operator-adjustable capabilities are contained in this table.
 - 2. These set points serve as a guide for startup and troubleshooting, and may change to adjust for future situations.
 - 3. Future equipment not installed at this time.

Table 4-2
Initial Equipment Functional Tests
American Chemical Services NPL Site,
Griffith, Indiana

Equipment Type (ID)	New/ Existing	Functional Tests
Gravity Phase Separator (T-101)	New	Level indicator, high level alarm and shutdowns, sludge pump operation, water valves
Mixing Tank (T-103)	New	pH control loop, mixer operation
Equalization/Aeration Tank (T-101)	New	Level indicator, level alarms, pump operation, air discharge piping, water valves, diffuser operation, pressure relief pipe
Catalytic Oxidizer/Scrubber (ME-106)	New	Vendor PLC, potable water, natural gas, and caustic supply, also see the manufacturer's manual contained in Volume 10 of this manual
Activated Sludge Plant (ME-101) (ME-1)	New	These test will be conducted in accordance with the manufacturer's operation and maintenance manual. Also sludge pump operation, high level switch, solenoid valve control, air supply system will be tested.
Phase Separator (ME-1)	Existing	Weir positioning, sludge pump operation, valve operation, filter media condition
Holding/Pumping Tanks (T-1, T-2, T-3, and T-4)	Existing	Level indicators, level alarms and shutdowns, pump controls, air release valves
Chemical Precipitation Unit (ME-4 through ME-6)	Existing	Vendor controls, pH control loop, sludge pump operation
Upflow Sand Filter (ME-7)	Existing	Vendor PLC, air and water flow control, backwash control
Sand Filter Beds (ME-8 and ME-9)	Existing	Valve operation, pressure gauges, automatic backwash system
GAC Contactors (ME-33 and ME-34)	Existing	Valve operation to switch configuration, pressure gauges
UV Oxidation Unit (ME-2)	Existing	UV lamp, vendor PLC operation and interface
Effluent pH Control/Monitoring	New	Flow meter operation, pH control, solenoid valve control
NAPL Storage Tank (T-6)	Existing	Level indicator, high level alarm, valve operation, air release valve
Sludge Storage/Thickening Tanks (T-5 and T-104)	Both	Level indicator, high level alarm, air release valve, water valves, sludge pump operation
Filter Press (ME-12)	Existing	Vendor PLC, body feed control, sludge pump operation, plate shifter
Blowers (ME-102 through ME-105)	Both	On/Off operation, low pressure switch, and other requirements in accordance with the manufacturer manuals
Flowmeters (FM-101 to FM-109, FM-801 to FM-803)	New	Mounting location and direction, electrical and control connections, unit settings
Caustic and Acid Storage Tanks (T-8 and T-9)	Existing	Level indicators, low-level alarms
Caustic Metering Pumps (P-22 and P-109)	Both	On/off/auto operation, automatic flow adjustment based on PLC input
Acid Metering Pumps (P-20 and P-21)	Both	On/off/auto operation, automatic flow adjustment based on PLC input
Chemical Metering Pumps (P-25, P-107, P-108, P-110, and P-111)	Both	On/off/auto operation, automatic flow adjustment based on PLC input
Sumps (North, Middle, South, Filter Press Area)	Both	Pump on/off, high-level alarms, pump on alarm
Turbidity Meter (DM-101)	New	Mounting location and direction, solenoid valve control, electrical and control connections, unit settings

Table 6-1
Recommended Process Monitoring Schedule
American Chemical Services NPL Site,
Griffith, Indiana

STARTUP/INTEGRATION MONITORING

Equipment	Location	Parameter	Frequency
Gravity Phase Separator (T-101)	Influent	BOD, COD, VOCs, SVOCs, Oil & Grease, Inorganics (metals), TSS, pH, PCBs	Once
	Effluent	BOD, COD, VOCs, SVOCs, Oil & Grease, TSS	Once
CPI Oil/Water Separator (T-103)	Effluent	Oil & Grease	Once
Equalization/Aeration Tank (T-102)	Influent	BOD, COD, VOCs, SVOCs, Oil & Grease, Inorganics (metals), TSS, PCBs	Once
	Interior	DO/OUR	Once
	Effluent	BOD, COD, VOCs, SVOCs	Once
Lamella Clarifier (ME-6)	Influent	Metals, TSS	Once
	Effluent	Metals, TSS	Once
Activated Sludge Plant (ME-101)	Influent	BOD, COD, VOCs, SVOCs, Phosphorous (T), Nitrogen (TKN, NO ₃ , & NH ₃)	Once
	Aeration Zone 1	TSS, VSS, DO/OUR, Settleability, Temp.	Once
	Aeration Zone 2	TSS, VSS, DO/OUR, Settleability, Temp.	Once
	Clarifier	Settleability	Once
	RAS	TSS, VSS	Once
	Effluent	BOD, COD, VOCs, SVOCs, TSS, Phosphorous (T), Nitrogen (TKN, NO ₃ , & NH ₃)	Once
Sand Filter (ME-7)	Effluent	TSS	Once
1,500-lb Sand Filter Beds (ME-8 and ME-9)	Influent	BOD, COD, VOCs	Once
	Effluent	BOD, COD, VOCs, TOC	Once
GWTP Effluent	Effluent	BOD, COD, VOCs, SVOCs, TSS, TOC, Inorganics (metals), PCBs	Once
Catalytic Oxidizer/Scrubber (ME-10)	Ox. Influent	VOCs, SVOCs	Once
	Ox. Effluent	VOCs, SVOCs	Once
	Scrub. Effluent	VOCs, SVOCs	Once
Vapor Phase Carbon Unit	Effluent	VOCs	Once

Notes:

The purpose of startup/integration monitoring is to obtain a baseline to assist in system optimization.

Temperature, pH, DO, and Settleability to be sampled and field analyzed.

Settleability to be analyzed in accordance with Section 5 of the Activated Sludge Plant Operation and Maintenance Manual (in Vol 10 of this manual)

COD to be analyzed by both the laboratory and in the field

Table 6-1
Recommended Process Monitoring Schedule
American Chemical Services NPL Site,
Griffith, Indiana

ACCLIMATION MONITORING

Equipment	Location	Parameter	Frequency
Gravity Phase Separator (T-101)	Influent	BOD, COD, Oil & Grease, TSS	1 per week
	Effluent	Oil & Grease, TSS	1 per week
CPI Oil/Water Separator (T-103)	Effluent	Oil & Grease	1 per week
Equalization/Aeration Tank (T-102)	Influent	BOD, COD, Oil & Grease, VOCs, SVOCs, TSS	1 per week
	Effluent	BOD, COD, VOCs, SVOCs	1 per week
Lamella Clarifier (ME-6)	Influent	Inorganics (metals), TSS	1 per week
	Effluent	Inorganics (metals), TSS	1 per week
Activated Sludge Plant (ME-101)	Influent	BOD, COD, VOCs, SVOCs, Phosphorous (T), Nitrogen (TKN, NO ₃ , & NH ₃)	3 per week
	Aeration Zone 1	TSS, VSS, DO/OUR, Settleability, Temp.	3 per week
	Aeration Zone 2	TSS, VSS, DO/OUR, Settleability, Temp.	3 per week
	Clarifier	Settleability	3 per week
	RAS	TSS, VSS	3 per week
	Effluent	BOD, COD, TSS, Phosphorous (T), Nitrogen (TKN, NO ₃ , & NH ₃)	3 per week
1st 1,500-lb GAC Unit (ME-8)	Influent	BOD, COD, TSS	3 per week
	Effluent	BOD, COD, TOC	3 per week
GWTP Effluent	Effluent	BOD, COD, TOC	3 per week
Catalytic Oxidizer/Scrubber (ME-10)	Ox. Influent	VOCs, SVOCs	1 per week
	Ox. Effluent	VOCs, SVOCs	1 per week
	Scrub. Effluent	VOCs, SVOCs	1 per week
Vapor Phase Carbon Unit	Effluent	VOCs	1 per week

Notes:

The purpose of acclimation monitoring is to acclimate the biomass in the activated sludge plant and optimize the GWTP.

Temperature, pH, DO, and Settleability to be sampled and field analyzed.

Settleability to be analyzed in accordance with Section 5 of the Activated Sludge Plant Operation and Maintenance Manual (in Vol 10 of this manual)

COD to be initially analyzed by both the laboratory and in the field. If COD routinely stays below 1,500 mg/L, then only field analysis needs to be done.

Table 6-1
Recommended Process Monitoring Schedule
American Chemical Services NPL Site,
Griffith, Indiana

STEADY STATE MONITORING

Equipment	Location	Parameter	Frequency
Gravity Phase Separator (T-101)	Influent	BOD, COD, Oil & Grease	1 per month
	Effluent	Oil & Grease	1 per month
Equalization/Aeration Tank (T-102)	Influent	BOD, COD	1 per week
		Oil & Grease, VOCs, SVOCs	1 per month
	Effluent	BOD, COD	1 per week
		VOCs, SVOCs	1 per month
Lamella Clarifier (ME-6)	Influent	Metals, TSS	1 per month
	Effluent	Metals, TSS	1 per month
Activated Sludge Plant (ME-101)	Influent	BOD, COD, Phosphorous (T), Nitrogen (TKN, NO ₃ , & NH ₃)	1 per month
	Aeration Zone 1	TSS, VSS	1 per week
		DO/OUR, Settleability, Temp.	3 per week
	Aeration Zone 2	TSS, VSS	1 per week
		DO/OUR, Settleability, Temp.	3 per week
	Clarifier	Settleability	3 per week
	RAS	TSS, VSS	1 per week
1,500-lb Sand Filter Beds Unit (ME-8 & ME-9)	Influent	COD	1 per week
		BOD	1 per month
	Effluent	COD	1 per week
		BOD	1 per month
10,000-lb GACs (ME-33 & ME-34)	Effluent	COD	1 per week
		BOD	1 per month
Catalytic Oxidizer/Scrubber (ME-10)	Ox. Influent	VOCs, SVOCs	1 per quarter
	Ox. Effluent	VOCs, SVOCs	1 per quarter
	Scrub. Effluent	VOCs, SVOCs	1 per quarter
Vapor Phase Carbon Unit	Effluent	VOCs	1 per quarter

Notes:

The purpose of steady state monitoring is for preventative maintenance and may be modified to meet current operating conditions.

Temperature, pH, DO, and Settleability to be sampled and field analyzed.

Settleability to be analyzed in accordance with Section 5 of the Activated Sludge Plant Operation and Maintenance Manual (in Vol 10 of this manual)

RAA\jmf\TMK

J:\209\601 ACS\0116 GWTP\6010116a063.xls/Table_6_1

Table 7-1
Recommended Spare Parts List
American Chemical Services NPL Site,
Griffith, Indiana

Equipment	Spare Part/Item	Quantity
PGCS Extraction Pumps	Pump motor or pump	3
BWES Extraction Pumps	Pump motor or pump	11
Influent Manifold Piping	1.5-inch Turbine flow meter	1
Mixing Tank	pH sensor	1
Equalization/Aeration Tank	Diffusers	4
Activated Sludge Plant	Clarifier roller chain	1
	Clarifier gearbox sprocket	1
	Secondary gearbox sprocket	1
	Skimmer timer limit switch	1
	Torque limiter	1
	Diffusers	4
	Diffuser "U" bolt	2
	Air drop pipe control valve	1
	Scraper blade	1
	Skimmer solenoid valve	1
	Air hose	1
Turbidity Meter	Sensor	1
Upflow Sand Filter	O-rings, air lift pump chamber	1
	O-rings, air lift inlet nut	1
	Screen, air lift pump	1
	Regulator, instrument air	1
	Air flow indicator	1
Effluent pH and Flow Control	pH sensor	1
	Magnetic flow meter	1
Filter Press	Filter cloth	1 set
	Gasket material	100 feet
	Air filter element	1
	Oil filter element	1
	Muffler element	1
Sludge Pumps	Diaphragms	2
	Air solenoid valve	1
	Ball check valves	1 set
Compressed Air System	Air filter elements	1/filter
Blowers	ME-102 & ME-103: 1 set of belts and an air filter for each blower	2
	ME-104 & ME-105: 1 set of belts and an air filter for each blower	2
Centrifugal Process Pumps	Motor (each kind of pump)	1
Chemical Feed System	Chemical metering pump	1
	Manufacturer's spare parts kit	3/brand
UV Oxidation System	UV lamp	1

Table 7-1
Recommended Spare Parts List
American Chemical Services NPL Site,
Griffith, Indiana

Equipment	Spare Part/Item	Quantity
Catalytic Oxidizer/Scrubber	See Manufacturers Owner's Manual	
Valves	2-inch ball (PVC)	4
	2-inch ball (stainless steel)	1
	3-inch ball (PVC)	2
	3-inch ball (stainless steel)	1
	4-inch ball (PVC)	1
	4-inch ball (stainless steel)	1
	2-inch solenoid valve assembly (PVC)	2
	Motor for 2-inch solenoid	2
	4-inch solenoid valve assembly (PVC)	1
	Motor 4-inch solenoid (PVC)	1
	3/4-inch air solenoid (stainless steel)	2
	1-inch air solenoid (stainless steel)	1
	2-inch check valve (PVC)	2
	2-inch check valve (stainless steel)	4
	1-inch check valve (PVC)	2

Table 7-2
Maintenance Schedule
American Chemical Services NPL Site,
Griffith, Indiana

Equipment/Process	Maintenance Items	Frequency
1. PLC/MCC	• Check screens and alarm data	daily
	• Check set points, flow and pH data	daily
	• Backup and print data	monthly
2. Extraction Wells Pumps	• Remove, disassemble and clean pumps	quarterly or as necessary
	• Clean and rehabilitate sumps	annually
3. GWTP Influent Header	• Clean internals of flowmeters	quarterly or as necessary
	• Clean flowmeter influent screen (where needed)	quarterly or as necessary
	• Exercise manifold valves	weekly
4. Gravity Phase Separator	• Exercise decant valves	monthly
	• Check for sludge buildup	monthly
	• Check for oil buildup	monthly
	• Clean level switch	quarterly if previously activated
5. Mixing Tank T-103	• Check, clean and calibrate pH probe	weekly
	• Check and clean chemical feed pump	monthly
	• Check mixer lubrication	monthly
	• Check mixer motor for overheating	monthly
	• Check mixer for vibration	weekly
	• Replace gear oil	annually
6. CPI Oil/Water Separator	• Inspect coalescing pack for damage or blockage	monthly
	• Check oil skimmer level	monthly
7. Equalization/Aeration Tank	• Check, clean and calibrate level sensor	monthly
	• Check pressure and vacuum breaker	weekly
	• Check and clean diffusers	annually or as needed
	• Check demister for blockage	quarterly or as needed
8. Chemical Precipitation	• Check, clean and calibrate pH probe	daily
	• Check and clean chemical feed pump	monthly
	• Check mixer lubrication	weekly
	• Check mixer motors for overheating	weekly
	• Check mixers for vibration	weekly
	• Check flocculator speed	weekly
	• Clean clarifier orifices and weirs	weekly
	• Check and clean clarifier plates	quarterly
	• Check and adjust sludge pump	weekly
	• Replace gear oil	annually
	• Tighten bolts and touch up paint	annually
9. Holding Tanks T-2 and T-3	• Check, clean and calibrate level sensors	monthly
10. Activated Sludge Plant	• Check reducer oil level in rake motor	weekly
	• Grease rake motor fittings	monthly
	• Clean reducer for rake motor	daily or as needed
	• Check reducer and foundation bolts for rake motor for tightness	annually
	• Inspect air distribution piping for leaks	annually
	• Inspect air distribution piping joint gaskets	monthly
	• Inspect and clean diffusers	as needed
	• Inspect the clarifier effluent weir for levelness	monthly
	• Remove foreign floating materials (leaves, etc.)	weekly
	• Clean clarifier effluent weirs	weekly
	• Check painted surfaces for paint chipping/flaking	monthly
	• Test solenoid valves and air lifts	semi-annually

Table 7-2
Maintenance Schedule
American Chemical Services NPL Site,
Griffith, Indiana

Equipment/Process	Maintenance Items	Frequency
11. Turbidity Meter	• Check, clean and calibrate turbidity sensor	quarterly or as needed
	• Check and clean solenoid valves	quarterly
10. Upflow Sand Filter	• Check and adjust backwash air flow	weekly
	• Check air filter	monthly
	• Check headloss	daily
	• Remove and inspect air lift	annually
12. UV Oxidation System	• Clean and calibrate pH probe	weekly
	• Exercise all valves	weekly
13. Sand Filter Beds	• Check GAC backpressure	daily
	• Replace filter media	as needed
	• Exercise valves	weekly
14. GAC Contactors	• Check GAC backpressure	daily
	• Replace carbon	as needed
	• Exercise valves	weekly
15. Effluent Monitoring	• Check, clean and calibrate pH probe	weekly
	• Check and clean flow meter	monthly
16. Chemical Feed Systems	• Check for unusual pump vibration	weekly
	• Check for motor overheating	weekly
	• Exercise all valves	weekly
17. Centrifugal Pumps	• Check for unusual pump vibration	weekly
	• Check for motor for overheating	weekly
	• Check lubricant levels	quarterly
	• Exercise all valves	weekly
	• Check and clean check valves	monthly or as needed
18. Sludge Transfer Pumps	• Check for unusual pump vibration	weekly
	• Exercise all valves	weekly
	• Check diaphragms	semi-annually
	• Check "O" rings and gaskets	quarterly
19. Filter Press	• Check filter cloth	each cycle
	• Wash filter cloth	as needed
	• Check plumbing	weekly
	• Check hydraulic oil level	weekly
	• Check hydraulic oil filter	monthly
	• Replace oil and filter	yearly
	• Grease fittings	quarterly
20. Catalytic Oxidizer/Scrubber	See Section 9 of the Catalytic Combustion Corporation Owner's Manual	
21. Sump Pumps	• Check for unusual pump vibration	weekly
	• Check for motor for overheating	weekly
	• Check lubricant levels	quarterly
	• Exercise all valves	weekly
	• Check and clean basket strainer	weekly
22. Blowers	• Inspect for excessive vibration, overheating, and unusual noises	daily
	• Check and lubricate motor	quarterly or 1,000 hours
	• Inspect the blower end plates	Every 2 years
	• Check oil level	weekly
	• Inspect belts for tension, wear, and cracking	weekly
	• Inspect shaft bearings for wear	quarterly
	• Inspect shaft seals for leaks	weekly
	• Check timing gear teeth for wear	quarterly
23. Compressed Air System	• Check all particulate and condensate filters	monthly
	• Check for unusual compressor vibration	weekly
	• Check and lubricate motor	quarterly

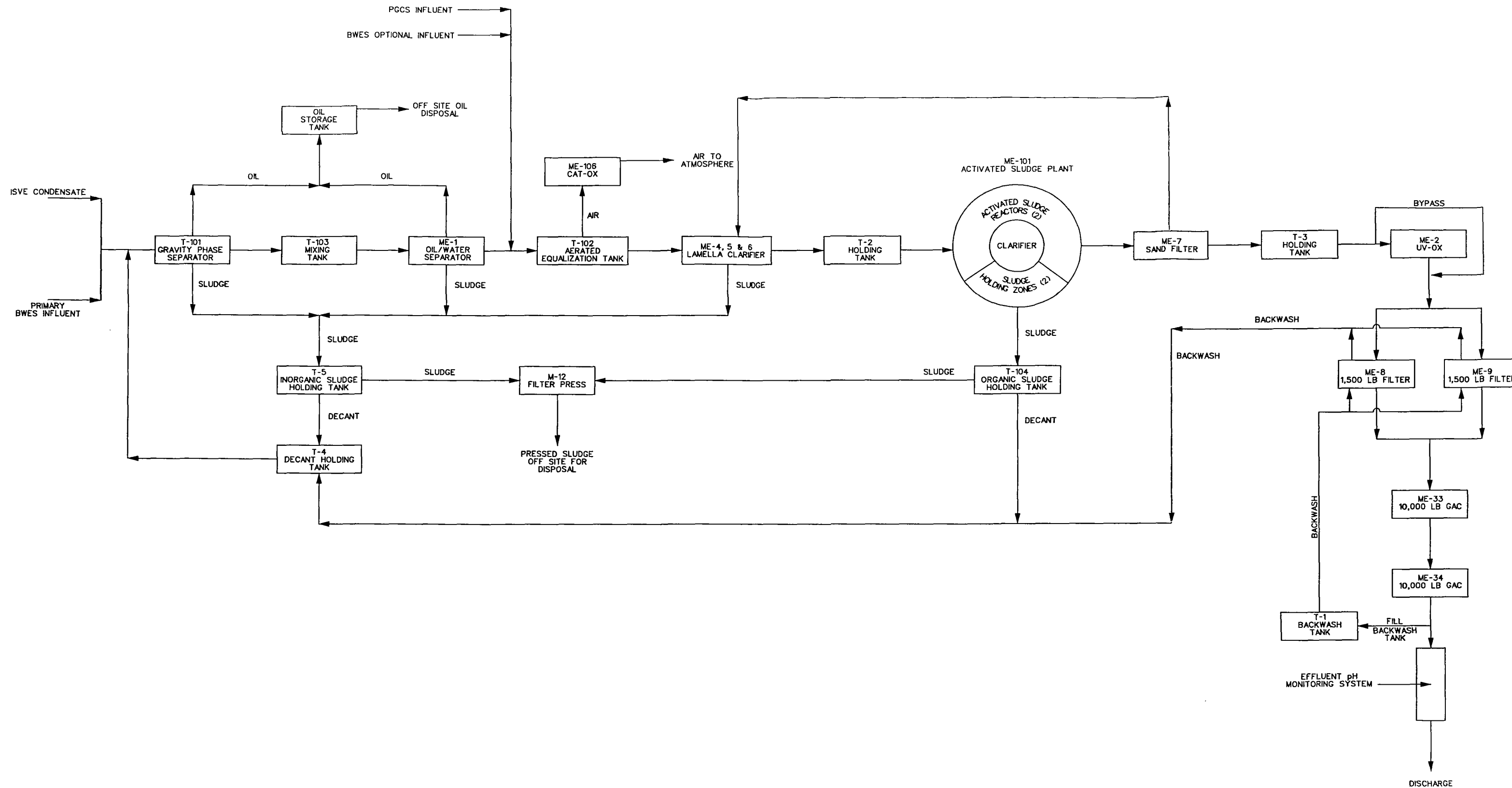


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Job No: MW Job



NOTES
ONLY PRIMARY PROCESS PIPES ARE SHOWN

REV	DATE	BY	DESCRIPTION	SCALE	WARNING 0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED RAA DRAWN RC CHECKED *	SUBMITTED BY (PROJECT MANAGER'S NAME) LICENSE NO. DATE (COMPANY OFFICER'S NAME) LICENSE NO. DATE
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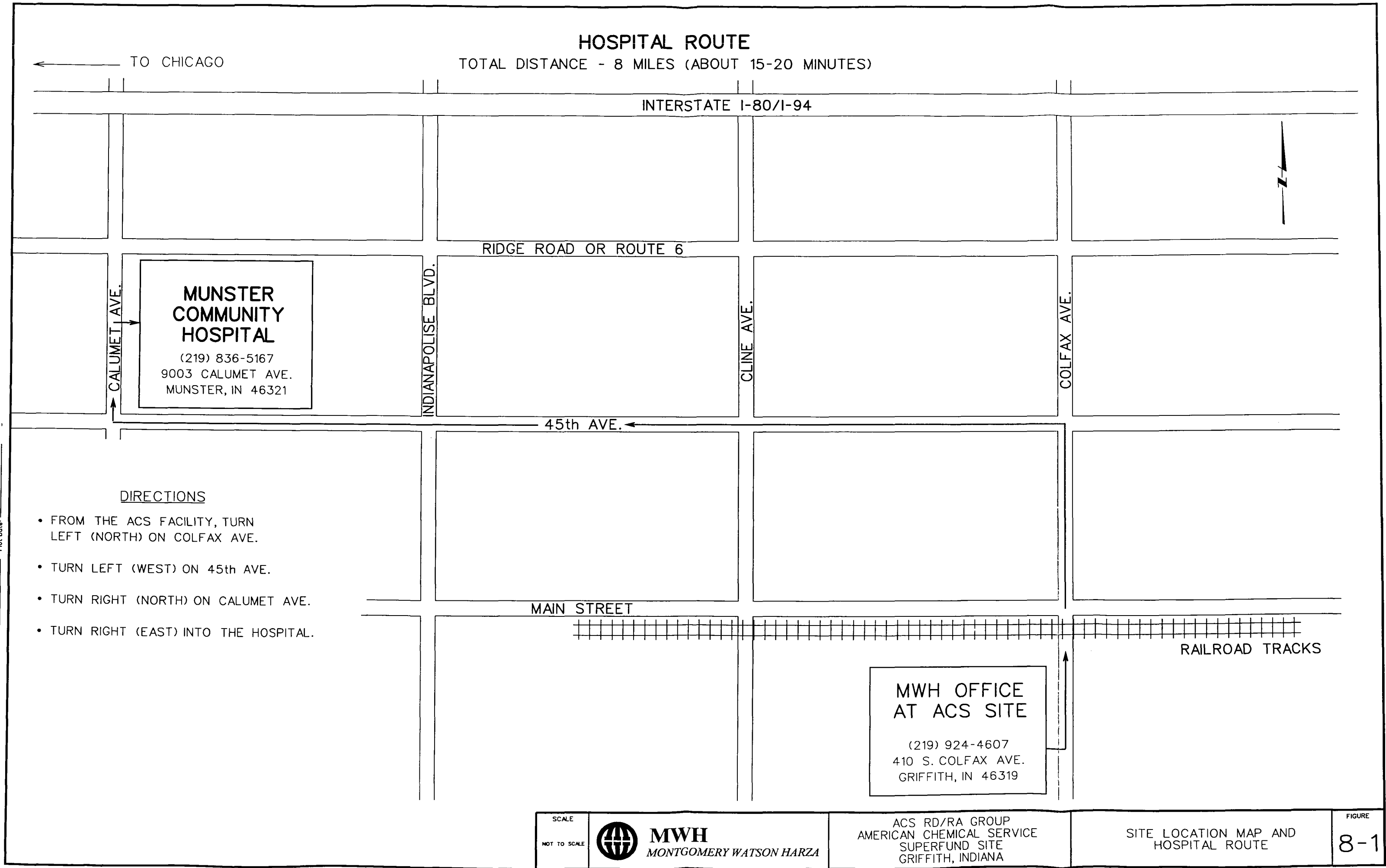
AMERICAN CHEMICAL SERVICE, INC.
GRIFFITH, INDIANA
OPERATION & MAINTENANCE MANUAL

GROUNDWATER TREATMENT PLANT
PROCESS BLOCK DIAGRAM

FIGURE
2-1



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APPENDIX A

Literature on PID Control Loops

PID: Additional Parameters

Clicking **Setup Screen** on the PID instruction displays a dialog that allows you to enter additional parameters. These parameters are described here.

◆ Tuning Parameters

Controller Gain Kc	Type in a value. (With 5/02 controllers the valid range is 0.1 to 25.5. With the 5/03, 5/04, and 5/05 controllers the valid range = 0 to 327.67.)	This is the proportional gain. Generally set this gain to one half the value needed to cause the output to oscillate when the reset and rate terms are set to zero. Note: <u>RG bit</u> must be set to accept values exceeding 25.5 when using 5/03, 5/04, and 5/05 processors.
Reset Ti	Type in a value representing minutes. (With 5/02 controllers the valid range is 0.1 to 25.5. With the 5/03, 5/04, and 5/05 controllers the valid range = 0 to 327.67.)	This is the integral gain. Generally set the reset time equal to the natural period measured in the Gain calibration above. Note: <u>RG bit</u> must be set to accept values exceeding 25.5 when using 5/03, 5/04, and 5/05 processors.
Rate Td	Type in a value representing minutes. (With 5/02 controllers the valid range is 0.1 to 25.5. With the 5/03, 5/04, and 5/05 controllers the valid range = 0 to 327.67.)	This is the derivative term. Generally set this value to 1/8 of the integral time above. Note: <u>RG bit</u> must be set to accept values exceeding 25.5 when using 5/03, 5/04, and 5/05 processors.
Loop Update	Type in a value representing seconds. (With 5/02 controllers the range is from 0.1 to 25.5. With the 5/03, 5/04, and 5/05 controllers the valid range is 0.01 to 10.24 seconds.)	This is the time interval between PID calculations. The entry is in 0.01 second intervals. Generally enter a loop update time five to ten times faster than the natural period of the load (determined by setting the reset and rate parameters to zero and then increasing the gain until the output begins to oscillate). When in the STI mode, this value must equal the STI time interval value S:30.
Control Mode	Select either E = SP - PV (Reverse Acting) or E = PV - SP (Direct Acting).	Reverse acting causes the output CV to increase when the input PV is smaller than the setpoint SP (for example, a heating application). Direct acting causes the output CV to increase when the input PV is larger than the setpoint SP (for example, a cooling application).
PID Control	Select either Auto or Manual .	Auto indicates that the PID is controlling the output. (Word 0, bit 1 is clear.) Manual indicates that the user is setting the output. (Word 0, bit 1 is set.)
Time Mode	Select either Timed or STI .	With Timed mode selected, the PID updates its output at the rate specified in the loop update parameter. When using the timed mode, your processor scan time should be at least ten times faster than the loop update time to prevent timing inaccuracies or disturbances. With STI mode selected, the PID updates its output every time it is scanned. When you

select STI, the PID instruction should be programmed in an STI interrupt subroutine, and the STI routine should have a time interval equal to the setting of the PID loop update parameter. Set the STI period in word S:3.0.

**Limit
Output CV**

Select Yes or No

Selecting **Yes** limits the output to minimum and maximum values. Selecting **No** applies no limits to the output.

**Deadband
DB**

Type in a value from 0 to the scaled max., or 0-16383 when no scaling exists.

This deadband extends above and below the setpoint by the value you enter. The deadband is entered at the zero crossing of the process variable PV and the setpoint SP. This means that the deadband is in effect only after the process variable PV enters the deadband *and* passes through the setpoint.

◆ **Inputs**

Setpoint SP

Type a value between 1-16383, or within valid scaled range

The desired control point of the process variable. Enter this value via your ladder program to the third word in the control block (word 2).

**Setpoint
Max
(Smax)**

Type in a value. (With 5/02 controllers the valid range is from -16383 to +16383. With the 5/03, 5/04, and 5/05 controllers the valid range is -32768 to +32767.)

If the setpoint is to read in engineering units, this corresponds to the value of the setpoint in engineering units when the control input is 16383.

**Setpoint
Min (Smin)**

Type in a value. (With the 5/02 controller the range is from -16383 to +16383. With the 5/03, 5/04, and 5/05 controllers the valid range is from -32768 to +32767.)

If the setpoint is to read in engineering units, then this parameter corresponds to the value of the setpoint in engineering units when the control input is zero.

**Process
Variable PV**

(Not editable, for display only)

This is the scaled value of the process variable (the analog input)

◆ **Output**

**Control
Output
CV (%)**

Type in a value from 0-16383 only if you selected manual mode.

Allows you to change the % of output control variable.

**Output Min
(CV%)**

Type in a value.

If **Limit Output CV is Yes**, the value you enter is the minimum output percent that the control variable CV will obtain. If CV drops below this minimum value, the CV is set to the value you entered and the output alarm lower limit (LL) bit is set.
If **limit Output CV is No**, the value you enter determines when the output alarm, lower limit bit is set. If CV drops below this minimum value, the output alarm lower limit (LL) bit is set.

**Output
Max (CV%)** Type in a value.

If **Limit Output CV** is **Yes**, the value you enter is the maximum output percent that the control variable CV will obtain. If CV exceeds this maximum, the CV is set to the value you entered, and the output alarm, upper limit (UL) bit is set.

If **limit Output CV** is **No**, the value you enter determines when the output alarm, upper limit bit is set. If CV exceeds this maximum value, the output alarm, upper limit (UL) bit is set.

**Scaled
Error SE** (Not editable, for display only)

This is the scaled error as selected by the control mode parameter. When using a 5/03, 5/04, or 5/05 processor, scaled errors larger than 32767 or smaller than -32768 cannot be represented.

◆ **Flags**

This information is available at [PID Status Indicators](#).

Related Topics

» [PID Runtime Errors](#)

» [PID Control Block Layout](#)

[View this as a full page](#)

Loop Optimization: Before You Tune

To Reap the Greatest Benefits, Define Your Objectives and Understand the Limitations of Your Equipment.

By Michel Ruel, P.E.

Reprinted with permission from CONTROL Magazine, March 1999

Plant efficiency and consistent product quality depend on proper loop performance, but tuning the controller is only the last step. This is the first of a three-part series on loop optimization. In April, Part II will describe how to optimize loop characteristics. And finally, in May, Part III will cover PID tuning.

There is much to be gained by optimizing control loops. It has been estimated that 80% of process control loops are causing more variability running in automatic mode than in manual. The often-quoted EnTech study showed that some 30% of all loops oscillate due to nonlinearities such as hysteresis, stiction, deadband, and nonlinear process gain. Another 30% oscillate because of poor controller tuning.

With a poorly optimized loop, an upset in the direction towards inefficiency results in giving away product. Alternatively, a load may cause off-spec product. When a control loop is running optimally, variability is minimized. Better tuning keeps the process on spec and reduces giveaway of often-expensive ingredients.

But tuning objectives vary for different types of processes. For example, in a steam header, the pressure has to be maintained at the maximum allowable without large errors so the safety valves will not open. The PID controller must be tuned tightly to ensure the valve that controls the flow from the main header will move quickly to eliminate effects of disturbances.

On the other hand, the PID controller of a robot arm that manipulates nitroglycerin vessels has a different objective. The control loop must be optimized to change the setpoint without overshoot or cycling.

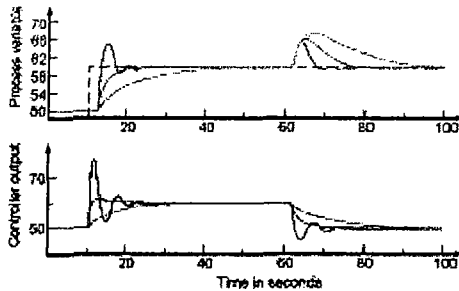
Performance Objectives

Most engineers and technicians tune process control loops using trial and error, observing the response to setpoint changes. To achieve good setpoint response takes a skilled intuitive understanding of the shape and speed of response. Only experienced people are able to achieve good setpoint response this way.

Unfortunately, once a loop is tuned for good setpoint response, the response to upset is usually very sluggish. Good setpoint tuning does not automatically result in good recovery from upsets. Unfortunately, it is upsets that usually are the source of off-spec product and poor variability.

Using modern tools to analyze a loop will give the engineer or senior technician helpful hints about the process: numbers and graphics will inform the user about design, equipment performance, and interactions with other loops. Modern tools also let the engineer or the technician select appropriate tuning parameters for the control objective. And since the algorithms used in PID controllers are different from one manufacturer to another, in many cases the algorithm is user selectable.

WHAT DO YOU WANT?



The same loop can be tuned for robustness (green), neutral response (blue), or speed (red) depending on the objectives.

The characteristics of good control (Table I) are difficult to obtain. When tuning a loop, one must make compromises between robustness and speed of response. Robustness is the ability of the control loop to remain stable when the process (mainly dead time or process gain) changes. Usually, to obtain robustness:

- Speed of response is longer,
- Errors are greater when a disturbance occurs, and
- Disturbances are not easily rejected.
- If the response is fast, it usually indicates:
 - The loop is less robust,
 - Errors are small when a disturbance occurs, and
 - Disturbances are quickly rejected.

The trends in Figure 1 show the same flow loop tuned for different objectives.

A control loop consists of the process, measurement, controller, usually a current to pneumatic (I/P) transducer,

WHAT IS GOOD CONTROL?

Good setpoint response without overshoot.

Good setpoint response with a maximum overshoot.

Response time matched with another loop so loops will be synchronized.

Response time long enough to ensure the loop will not react with another loop.

Load disturbance quickly rejected.

Load disturbance rejected without cycling.

Robust tuning so the loop will remain stable when the process changes.

Aggressive tuning so the error will remain small enough to keep the product in specs.

and valve. Optimal process control depends on all of these components working properly. Hence, before tuning a loop, one must verify if each component is operating properly and if the design is appropriate.

Choosing the optimal PID tuning should be done after making sure all of the other components are working properly. The optimal tuning parameters ensure your equipment is used at maximum efficiency.

Questions to Be Answered

The following steps outline a procedure for approaching and optimizing a process control loop. Optimization requires observation in manual and automatic modes, and at various operating conditions. We need to answer the following questions:

1. Process gain: Is the control valve sized properly? Often, valves are oversized. If so, the controller output will be at one end of the range when the loop is in automatic. Also, oversizing the valve will amplify nonlinearities such as hysteresis, stiction, different response to small and large changes, and operating near the seat.

The process gain should be between 0.3 and 3. The ideal process gain is 1. A process gain too high will not permit the controller to work at its full potential: the controller will have to be tuned with a small proportional gain.

2. Hysteresis/stiction: Does the control valve have harmful hysteresis and/or stiction? Hysteresis is a difficulty but stiction is really the main problem. Stiction occurs when friction is present.

Hysteresis should be less than 3%, significantly less if the loop is to be tuned tightly. Stiction should be less than 1% and often 1% is too much.

3. Sensor/transmitter: Is the measurement sensor working properly? From your experience, do the numbers make sense? For example, is the dead time small enough? If a transmitter is not properly installed, the dead time can be too long; if a filter is added in the transmitter, the equivalent dead time could be longer.

4. Noise band: Is there an excessive amount of noise in the loop? When disturbances occur too fast to be removed by the PID controller, they are called noise. Filtering may help. The filter should be small enough to not increase the equivalent dead time and large enough to reduce the noise.

Selecting the filter time constant is a tradeoff between increasing the equivalent dead time and reducing the amount of noise. When the noise is reduced, the controller output is smoother.

5. Nonlinearities: How nonlinear is the loop? A loop is nonlinear when the process gain varies. All loops are somewhat nonlinear. It is the degree of nonlinearity that we are interested in. If the loop gain varies by more than a factor of two or three, then linearization will help optimize the loop.

6. Asymmetry: Does the loop respond differently in one direction than in the other? Often, a valve responds more quickly in one direction than the other. Also, in temperature processes using one fluid to add heat and another to remove heat, the two fluids are different and the characteristics of the process are different.

If the equivalent dead time or the equivalent time constant are different depending on the direction, use the worst case to tune the loop or use a special algorithm.

7. Tuning: Is the loop optimally tuned? If the loop is tuned aggressively to minimize error, the robustness is small; if the loop is tuned sluggishly to reduce variability, the recovery time after a

disturbance is long.

Tuning parameters are selected to make a compromise between robustness and performance. The loops upstream could interact--selecting the appropriate tuning parameters will allow decoupling. At the opposite, if loops need to be synchronized, selecting the appropriate tuning parameters will ensure they work in accordance.

Next: Diagnosis

Each of these problems has a characteristic signature, which can be found by performing a series of tests and analyzing the results. The tests, which will be covered in detail in the next installment of this series, start with collecting process variable and controller output data with the controller in automatic at normal operating conditions, then introducing a setpoint change. Data is also collected with the loop in manual mode.

You will be able to see how the operating range for the valve and its performance can tell you if the valve is sized correctly; whether loop cycling is being caused by hysteresis, nonlinearities, or poor tuning; and the other critical aspects of loop performance that must be understood before tuning the controller.

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Operating Instruction Manual

**Manual No. P63
Revision 4-298**

**MODEL P63
pH ANALYZER**

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Consequently, when using the wash/cal method you must preset the analyzer with low and high buffer values before starting any calibration. (To select and enter buffer values, refer to the "Pre-Defined Buffer Method" subsection previously described in this section.) After a pre-defined buffer is dispensed to the sensor, calibration automatically starts. When a single-point calibration is required, only one of the pre-defined buffers is needed.

The length of time it takes for the analyzer to calibrate a point is determined by the selected threshold rate (LO, MED or HI – also previously described in the "Pre-Defined Buffer Method" subsection). The analyzer uses the selected threshold rate to determine when the pH and temperature measurement signals are acceptably stable to complete calibration of that point. (You do not need to watch for the "pH" and "°C" annunciators to stop flashing and then press the **ENTER** key to complete calibration of that point.)

4.5 Temperature Calibration

The analyzer is factory-calibrated for highly accurate temperature measurement. You need to calibrate only when the very highest accuracy is required. **However, do not attempt to temperature calibrate the analyzer unless you have accurate temperature standards (accurate to within 0.1°C), and are able to wait for the system to come to temperature equilibrium (approximately 30 minutes for each calibration point).** Follow the simple instructions shown on the analyzer display screens.

SECTION 5

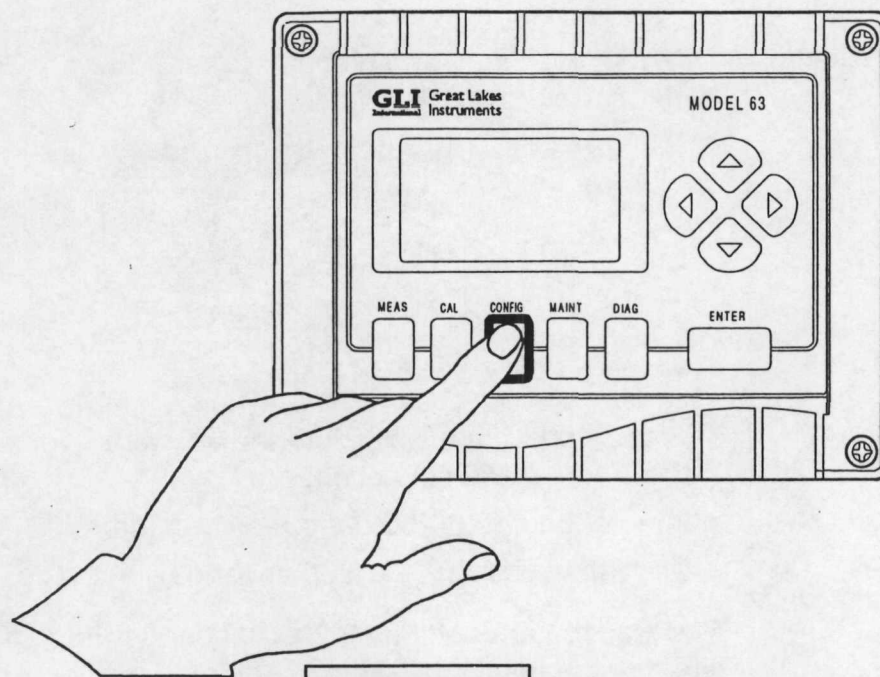
THE CONFIGURATION MENU

The CONFIG root menu, accessed by pressing the **CONFIG** key, enables you to configure the analyzer to your application requirements. If you select a submenu to configure an option that is not installed on your analyzer, an "Invalid" text box appears on screen to inform you of this situation.



5.1 CONFIG Menu Structure

Refer to Figure 3-3 for the CONFIG root menu structure. If a passcode has been assigned (Section 5.13), you must successfully enter it to access the configuration menus.



CONFIG Menu

PASSCODE (optional)

- PID Operation
- Relay/TTL Outputs
- Wash/Cal System
- Temp Comp Method
- Analog Output #1
- Analog Output #2
- Main Parameter
- Transfer Condition
- Software Alarms
- Meas Screen Setup
- Set Time/Date
- Set Passcodes
- RETURN (press **ENTER** to return to measure screen)

Select choice and
press **ENTER** for
submenu screen

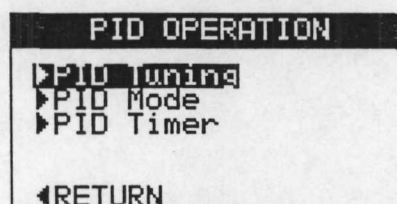
- or -

Press **MEAS** or
CONFIG to return to
measure screen

FIGURE 3-3 CONFIG Menu Structure

5.2 The PID Controller (optional)

To enable PID controller operation, first configure analog output #1 to represent the "PID" controller (see Section 5.6). Then select "PID Operation" from the CONFIG root menu to access the three submenus to configure the PID controller:



PID Tuning

Use the "PID Tuning" submenu to tune the controller to the dynamics of your pH process:

PID TUNING	
Prop	3.58
Integral	6.91 /min
Deriv	2.00 s
Transit	47 s
◀SAVE & RETURN	

The screen shows settings for:

- Proportional gain (-99.99 to +99.99 with - for reverse action and + for direct action)
- Integral gain (0.00-50.00 repeats/minute)
- Derivative gain (0.00-10.00 seconds).

The transit time setting (0-2000 seconds) is displayed only when the velocity algorithm is selected for controller operation (see below).



NOTE: Integral gain may be disabled by entering "0.00" to provide PD controller action.

PID Mode

Use the "PID Mode" submenu to configure the controller to your application requirements:

PID MODE	
Type	ISA VEL
Full Scale	14.00 pH
Zero Scale	0.00 pH
Set Pt	7.00 pH
Man Reset	0.0 %
◀SAVE & RETURN	

The controller can be selected to use a velocity algorithm or an ISA (Instrument Society of America) algorithm. Both algorithms have anti-windup. The velocity algorithm takes into account process deadtime (transit time), but the ISA algorithm does not (except by purposely de-tuning the controller).

When using the "Man Reset" setting (0.0-100.0%), enter the desired controller output value you want provided when the measured pH is at the controller set point value.

PID Timer

You can independently set two controller output timer alarms (0.0% & 100.0%). Alarm signals will be provided whenever the controller output remains at 0.0% or 100.0% for longer than the respectively entered times (see Section 5.7 for details).

PID TIMER	
100% Timer	ON OFF
Time Out	10 min
0% Timer	ON OFF
Time Out	7 min
◀SAVE & RETURN	

The PID controller output changes as needed, based on controller settings, while you are in any of the CONFIG, MAINT or DIAG root menus or their respective submenus. However, while in the CAL or MAINT menu, you can select the controller output to change normally, hold its present value, or transfer to a predetermined value.



Configuration Tip! Before tuning the controller to the process dynamics, control the process manually (Section 6.3). This enables you to check the control element for proper sizing and to familiarize yourself with the capability of the control system.

5.3 Setting Relays and TTL (NAMUR) Outputs

Relays

After initially tuning the controller, readjustment (based on experimentation and observed response) is usually required until you attain desired control.

Select "Relay/TTL Outputs" from the CONFIG root menu to display the present mode (in parenthesis) for each relay and the NAMUR TTL outputs:

```

RELAY/TTL OUTPUTS
▶Relay A    (CONTROL)
▶Relay B    (ALARM)
▶Relay C    (CONTROL)
▶NAMUR TTL (DISABLED)
◀RETURN
  
```

Select the relay you want to configure (A, B, or C), and press ENTER to display its specific configuration screen showing all present settings. The configuration choices "Parameter", "Fail Safe", "Type", "On Delay", and "Off Delay" are always available. The remaining choices are specific to the selected relay type (control or alarm). A Typical setup screen for a control relay is shown below:

```

RELAY A
Parameter  pH  TEMP
Fail Safe  ON  OFF
Type       CONTROL ALARM
Phase      HIGH LOW
Set Pt     7.83 pH
+DBand     0.20 pH
  
```

- **Parameter:** The "pH" choice assigns the relay to be driven by the measured pH; "TEMP" assigns the relay to be driven by the measured °C. The "Parameter" line selection determines the measurement units shown for the relay setup fields.
- **Fail Safe:** "OFF" disables fail safe operation so that when the relay is on, the relay annunciator is also on (normal operation). Conversely, selecting "ON" enables fail safe relay operation which turns the relay annunciator off when

OPERATING INSTRUCTION MANUAL

Model 63 PID Controller Supplemental Manual

(for use with Model P63 pH Analyzer)

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In the interest of improving and updating its equipment, GLI reserves the right to alter specifications to equipment at any time.
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HELPFUL IDENTIFIERS

In addition to information on Model 63 PID controller operation, this instruction manual may contain WARNINGS pertaining to user safety, CAUTIONS regarding possible instrument malfunction, and NOTES on important, useful operating guidelines.

A WARNING LOOKS LIKE THIS. ITS PURPOSE IS TO WARN THE USER OF THIS ANALYZER OF THE POTENTIAL FOR PERSONAL INJURY.

A CAUTION LOOKS LIKE THIS. ITS PURPOSE IS TO ALERT THE USER OF THIS ANALYZER TO POSSIBLE INSTRUMENT MALFUNCTION OR DAMAGE.


 **NOTE:** *A note looks like this. Its purpose is to alert the user of this analyzer to important operating information.*

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PART ONE - GENERAL INFORMATION

SECTION 1

THE PID CONTROLLER

A PID (Proportional-Integral-Derivative) controller is one whose output is a sum of these three terms derived from operations on the difference between the measured process pH and the desired value at which you want to control the process (setpoint). The controller output drives a final control element, such as a modulating valve, that can act to bring the process pH to the setpoint value.

The following equation defines the relationship between controller functions:

$$m = P \left[(pv - r) + I \int (pv - r) dt + D (dpv \div dt) \right]$$

where:

m = controller output
P = proportional gain
pv = measured process pH
r = setpoint
I = integral gain
D = derivative gain

SECTION 2

GAIN FACTORS

■ PROPORTIONAL GAIN SETTING:

(Entry range: -99.99 to + 99.99)

The proportional gain factor increases or decreases the controller output in direct proportion to the control error ($p_v - r$, in the preceding equation). A positive value proportional gain entry provides direct control action (increasing error increases the controller output). Conversely, a negative value proportional gain entry provides reverse control action (decreasing error increases the controller output).

■ INTEGRAL GAIN SETTING:

(Entry range: 0.00 to 50.00 repeats per minute)

The integral gain factor increases or decreases the controller output in direct proportion to the time integral of the error. If the error is constant, the correction increases with time. It is an inherent property of proportional control that it does not bring the process to the setpoint all of the time. Integral action forces the process to the setpoint (unless the controller is improperly tuned).

The action of the controller varies with the integral gain value. If integral gain is set to a non-zero value, then the integral action is automatic. If integral gain is set to "0.00 /min", the controller has "manual reset", enabling a fixed offset to be added to the controller output.

■ DERIVATIVE GAIN SETTING:

(Entry range: 0.00 to 10.00 seconds)

The derivative gain factor increases or decreases the controller output in direct proportion to the rate of change of the process value. The derivative gain is used to compensate for second order effects in the process. Most processes have one dominant response time, such as the response to mixing in a tank. If there are two response times in the process, derivative gain helps compensate for the second response time. If a process has only one dominant response time, derivative gain will not help. It is best to start tuning the controller without any derivative gain.

SECTION 3

AUTO/MANUAL OPERATION

The Model 63 PID controller can be transferred between an automatic mode in which the PID routine calculates the output, and a manual mode in which the output is manually adjusted. To select the controller operating mode:

1. Press the **MAINT** key, select "Manual PID" from the menu, and press **ENTER**.
2. Select the desired mode (AUTO or MAN).
3. Depending on the selected controller operating mode, do one of the following:
 - **For AUTO Mode:** Press the **ENTER** key.
 - **For MAN Mode:** Select the value at the right and jog it up or down using the \uparrow or \downarrow keys until the desired controller output is displayed. The adjusted output is provided while the controller remains in the MAN mode. The value can be further adjusted at any time.

When the controller is returned to the AUTO mode, its output is derived by the PID routine. The AUTO mode output begins at the last MAN mode output value and then changes according to controller calculations. This provides bumpless transfer between the MAN and AUTO modes of operation. The output changes smoothly without abrupt jumps that could damage a final control element.

SECTION 4

CONTROLLER OUTPUT TERMINALS

The "4-20 mA" terminals for analog output #1 are always used as the PID controller output. (Disregard the "analog output" terminal designation on the analyzer since this output cannot be used for this purpose.) When an analog output signal is needed to represent the measured pH or temperature, analog output #2 must be used.

PART TWO - TUNING GUIDELINES

SECTION 1

INTRODUCTION

Most controllers are actually tuned by setting only the proportional gain and integral gain factors to some initial, arbitrary values. These settings are then readjusted, one at a time, by experimentation based on observed response.

Excessive process noise may require the controller to be detuned somewhat (proportional gain increased and derivative gain decreased). Successful control relies on proper selection of the control element and the controller range. For self-regulating processes, a full-scale stroke should provide a full-scale change in the measurement signal. pH applications typically have an integrating response. Avoid using integral gain unless the derivative gain can also be used. Neither of these gains are needed if the proportional gain setting is more than 90.00.

After setting the controller range and setpoint, and controlling the process manually, use the Ultimate Oscillation Tuning Method to tune the controller.

SECTION 2

ALGORITHM TYPE (ISA OR VELOCITY?)

The Model 63 PID controller can be selected to use an ISA (Instrument Society of America) or velocity algorithm. Both algorithms have "anti-reset windup" which prevents the output from remaining at its minimum or maximum value when the process is recovering from an upset condition.

The velocity algorithm, with its transit time setting, is intended for use on pH control processes with more than 5 seconds of dead time in the control loop. Do not use the velocity algorithm if the typical process pH changes very slowly. When process deadtime is less than 5 seconds, or the pH tends to change very slowly, select the ISA algorithm. To select the algorithm type:

1. Press the **CONFIG** key, select "PID Operation" from the menu, and press **ENTER**.
2. With the "PID OPERATION" screen displayed, select "PID Mode" and press **ENTER**.
3. With the "PID MODE" screen displayed, select the desired algorithm.

SECTION 3

FULL SCALE/ZERO SCALE SETTINGS

The "Full Scale" and "Zero Scale" fields on the "PID MODE" screen define the range of inputs over which the controller will act. **Recommendation:** For normal pH control, leave these settings at their factory defaults of "14.00" and "0.00" respectively. To change these settings:

1. With the "PID MODE" screen displayed, select the "Full Scale" value and adjust it using the \uparrow and \downarrow keys.
2. Select the "Zero Scale" value and adjust it using the \uparrow and \downarrow keys.

SECTION 4

SETPOINT SETTING

The controller setpoint is the pH value to which the controller should bring the process. To set the setpoint:

1. With the "PID MODE" screen displayed, select the "Set Pt" field.
2. Use the \uparrow and \downarrow keys to adjust the displayed value to be the desired setpoint, and press **ENTER**. This simultaneously enters all of the items on this screen (type, full scale, zero scale, and set pt).

SECTION 5

MANUAL RESET SETTING

The "Man Reset" value should always be "0.0%" whenever the controller's integral gain is set to a non-zero value. When the integral gain is set to "0.00 /min.", the controller becomes a PD (proportional + derivative) controller. In this case, select "Man Reset" and adjust the value using the \uparrow and \downarrow keys to establish a desired controller output that will be provided when the process value is at the setpoint.

SECTION 6

DIRECT/REVERSE CONTROL ACTION

Direct or reverse control action is set by the sign of the proportional gain setting. A positive or "+" gain value provides direct action. That is, increasing error causes increasing output. (Use a positive gain factor for acid addition.) Conversely, a negative or "-" gain value provides reverse action. That is, decreasing error causes increasing output. (Use a negative gain factor for caustic addition.)

SECTION 7

TRANSIT TIME SETTING



NOTE: Set a transit time only when the velocity algorithm has been selected, and only when there is more than 5 seconds of process dead time.

Transit time is the time it takes for the sensor to “see” a change in the process pH that was caused by a change from the connected control element. Transit time compensates for the process dead time by establishing an amount of time the controller “holds” before it “acts” to change the output as needed. The sequence of “hold” and “act” times continues automatically while the controller is in the AUTO mode of operation.

To determine the transit time, control the process manually. This also enables you to get a sense of control system capability, and to check for proper control element sizing.

1. **Recommendation:** Use a strip chart recorder to observe the effect of the control element on the process pH.

NOTE: Since analog output #1 is dedicated as the controller output, connect the recorder to appropriate analog output #2 terminals. Make sure that output #2 is configured to represent the measured pH.

2. Place the controller in the MAN operating mode. See Part One, Section 3 for details.
3. Manually jog the controller output to control the process in a safe direction towards the setpoint.
4. Time how long it takes for a change to affect the measured pH value. Note this transit time.
5. Press the **CONFIG** key, select “PID Tuning” from the menu, and press **ENTER**.
6. With the “PID TUNING” screen displayed, select the “Transit” value and, using the \uparrow and \downarrow keys, adjust it to match the time noted in step 4.
7. Press **ENTER** to enter the transit time.

SECTION 8

ULTIMATE OSCILLATION TUNING METHOD

8.1 Proportional Gain
Effect on Response

This method requires that the measuring loop response develops undamped oscillations that may be undesirable from an operational or safety viewpoint. Preventing these oscillations from growing or reaching some physical limit may be difficult.

By increasing proportional gain, the setpoint offset (sustained error) decreases but response becomes more oscillatory. The following diagrams illustrate this effect, with proportional gain settings of +75.00 for Curve 1, +65.00 for Curve 2, and +50.00 for Curve 3. A proportional gain entry of "0.00" disables the controller.

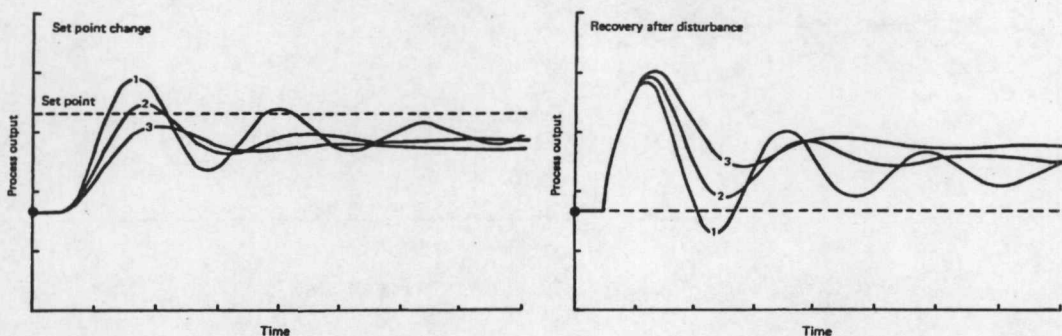


FIGURE 2-1 Proportional Gain Effect on Response

8.2 Integral Gain
Effect on Response

By increasing integral gain, the setpoint offset is eliminated faster but the response becomes more oscillatory. If integral gain is increased too much, oscillations develop into a reset cycle whose period is much longer than the "ultimate" period. The following diagrams illustrate this effect, with integral gain settings of 0.02 repeats/minute for Curve 1, 0.05 for Curve 2, and 0.10 for Curve 3. An integral gain entry of "0.00" disables integral response, but provides manual reset, enabling a fixed offset to be added to the controller output.

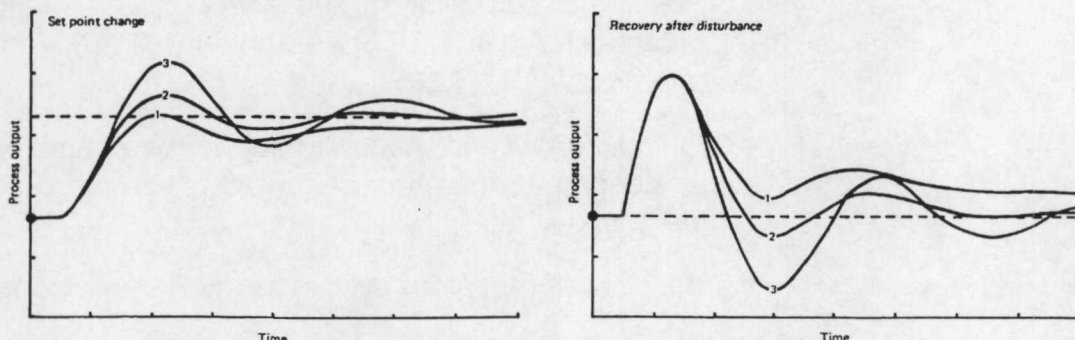


FIGURE 2-2 Integral Gain Effects on Response

8.3 Derivative Gain Effect on Response

By increasing derivative gain, the overshoot for setpoint changes and the peak error for load disturbances reduces, but response becomes more oscillatory. If response turns back as the pH approaches the setpoint before actually crossing the setpoint, the derivative time is longer than normal. If derivative gain is increased too much, oscillations develop into a rate cycle whose period is shorter than the "ultimate" period. The following diagrams illustrate this effect, with derivative gain settings of 2.00 seconds for Curve 1, 5.00 for Curve 2, 10.00 for Curve 3, and 20.00 for Curve 4. A derivative gain entry of "0.00" disables the derivative response.

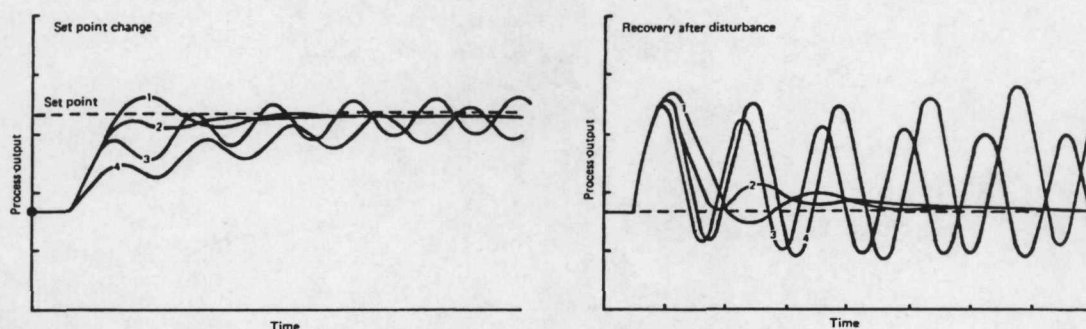


FIGURE 2-3 Derivative Gain Effect on Response

8.4 Tuning Procedure

1. Use a strip chart recorder to monitor the process. It must be connected to analog output #2 terminals, since output #1 is the controller output. Make sure output #2 is configured to represent the measured pH.
2. Display the "PID TUNING" screen by pressing **CONFIG**, selecting "PID Operation" from the menu, and pressing **ENTER**. Then enter the following gains:
 - Proportional gain: "0.00"
 - Integral Gain: "0.00 repeats/minute"
 - Derivative Gain: "0.00 seconds"
3. Place the controller in the MAN operating mode by pressing **MAINT**, selecting "Manual PID" from the menu, and pressing **ENTER**.
4. Select "MAN" and manually adjust the controller output as needed to drive the measured pH as close as possible to mid-scale.
5. Now transfer the controller to the AUTO operating mode.

6. Display the "PID TUNING" screen again, and increase the proportional gain setting in 5.00 increments until the observed oscillations neither grow nor diminish in amplitude. Note this proportional gain setting, referred to as PG_U (ultimate proportional gain) for this tuning method. If the oscillations saturate at either extreme, repeat steps 3 and 4 to stabilize the response. If there are not enough disturbances to start the oscillations, jog the setpoint.



NOTE: Oscillations only need to be approximately, not exactly, equal in amplitude.

7. At this PG_U setting, time the period between oscillations. This time is referred to as T_U (ultimate time). If the recorder chart speed is too slow, time the interval between the first and third measurement trace past the controller setpoint.
8. Depending on the gains you intend to apply, use one of the following sets of equations, and the PG_U setting and T_U time period noted in steps 6 and 7 to calculate the estimated settings for the controller gains:

- When using only proportional gain:

$$\text{Estimated proportional gain} = 0.55 \times PG_U$$

- When using proportional + integral gains:

$$\begin{aligned}\text{Estimated proportional gain} &= 0.45 \times PG_U \\ \text{Estimated integral gain} &= 0.83 \times T_U\end{aligned}$$

- When using proportional + integral + derivative gains:

$$\begin{aligned}\text{Estimated proportional gain} &= 0.6 \times PG_U \\ \text{Estimated integral gain} &= 0.5 \times T_U \\ \text{Estimated derivative gain} &= 0.125 \times T_U\end{aligned}$$

9. Enter each of the estimated gains calculated in step 8.

SECTION 9

FINAL TUNING

The typical procedure for testing the gain settings is to observe the performance of the controller when the output is upset. With the process being successfully controlled, manually jog the controller output up or down by a safe amount, return the controller to AUTO operation, and observe the control action as the controller brings the process back to setpoint. If the process value becomes unstable, oscillates, or does not return to setpoint in a reasonable amount of time, individually readjust the gains in small increments and observe the response.